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PATENT COOPERATION TREATY

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[ ] the applicant [ ] the inventor [X] the agent [ ] the common representative

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3. Further observations, if necessary:

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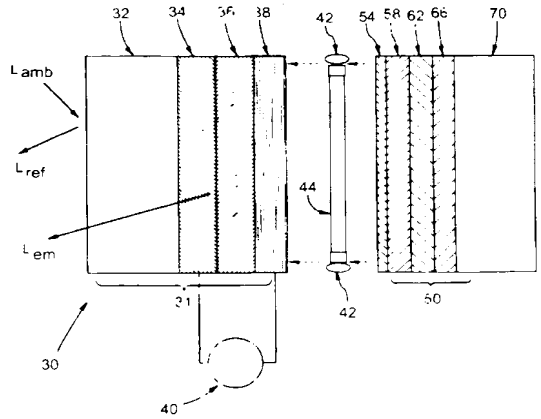
(54) **Title:** OPTICAL INTERFERENCE LAYER FOR ELECTROLUMINESCENT DEVICES



(57) **Abstract:** The present invention provides a transparent electroluminescent device (30) having an optical interference member (50) which reduces the overall reflectance from the device. The optical interference member (50) is formed on a substrate (70), typically comprising a reflective layer (66), a transparent layer (62), a semi-transparent layer (58) and an anti-reflective coating (54). The optical interference member (50) can then be affixed behind the electroluminescent display (31) with a transparent rear electrode (38). When affixed, the optical interference member (50) can reduce reflectance from ambient light and serve as a passivation layer that protects the elements of the electroluminescent device (31) from exposure to external elements. The optical interference member (50) can increase the reflectance of infra-red ambient light, compared to absorbing films, to thus reduce the overall heating of the display. Furthermore, the optical interference member (50) can absorb light emitted towards the back of the display from the electroluminescent layer (31), thus reducing pixel blooming and improving the overall characteristics of the device. In an other embodiment of the invention, the passivation layer can be added without the optical interference layer.

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OPTICAL INTERFERENCE LAYER FOR ELECTROLUMINESCENT DEVICES

TECHNICAL FIELD

The present invention relates generally to electroluminescent devices and more specifically relates to an electroluminescent device having one or more thin film optical interference layers to reduce reflectance from ambient light.

BACKGROUND ART

Electroluminescent devices (ELDs) are well known and are generally constructed of several layers of different materials. These layers typically consist of a transparent front-electrode layer, an electroluminescent layer and a back-electrode layer. When a voltage is applied across the electrodes, the electroluminescent layer becomes active, converting some portion of the electrical energy passing therethrough into light. This light is then emitted out through the front-electrode where it is visible to a user of the device.

Electroluminescent devices can be particularly useful as computer displays and are generally recognized as high-quality displays for computers and other electronic devices used in demanding applications such as military, avionics and aerospace where features such as high reliability, low weight, and low power consumption are important. Electroluminescent displays are also gaining recognition for their qualities in automotive, personal computer and other consumer industries, as they can offer certain benefits over other displays such as cathode-ray tubes ("CRT") and liquid crystal displays ("LCD").

One feature of electroluminescent displays is the ability to add thin films to vary the characteristics of the display. It is known to use thin film layers in electroluminescent displays to improve selected display characteristics, such as signal-to-reflected-ambient light ratio ("SRA") and contrast ratio ("CR").

One particular type of thin-film layer that can be used to improve contrast ratio in electroluminescent devices is a substantially transparent optical interference layer placed between one or more of the layers of the electroluminescent device, as taught in U.S. Patent 5,049,780 to Dobrowolski.

Using the principle of destructive interference, the optical interference layer can result in the reduction of the amplitude of ambient light by superimposing of two or more, out-of-phase, electromagnetic waves, which can be generated by reflection and/or transmission at the interfaces of thin-film layer(s). By selecting appropriate thicknesses of the layers, optical destructive interference at the electromagnetic wavelengths of interest (typically visible ambient light waves reflected off of the display) can result in an exceptional contrast ratio and/or signal-to-reflected ambient light ratio.

Dobrowolski is generally directed to voltage-driven inorganic electroluminescent devices, where the electroluminescent layer is formed of an inorganic material, and which typically require one or more additional transparent dielectric layers to reduce electrical-breakdown of the inorganic electroluminescent layer. Such inorganic electroluminescent devices are typically voltage-driven, powered with alternating current ("ac") in order to reduce charge build-up within the device. While Dobrowolski does generally contemplate the use of direct current ("dc") electroluminescent devices without transparent dielectric layers, such inorganic devices are still voltage-driven, and are generally prone to electrical breakdown of the electroluminescent layer. Modern, current-driven organic electroluminescent devices can offer certain advantages, such as colour improvements and a reduced barrier to current flow to reduce the necessary drive voltage, when compared to voltage-driven inorganic electroluminescent devices, and as such the teachings of Dobrowolski do not address these issues.

It is known to reduce ambient light on organic electroluminescent devices by placing a filter or other absorbing layers in front of the electroluminescent layer and/or the rear electrode. Such filters can absorb ambient light incident on the device and thus improve the viewing characteristics of the device. Filters do not, however, reduce pixel blooming, whereby emitted light is reflected off the rear of the device and then emitted through the front in such a manner as to cause the appearance of "bloomed" pixels, thus having deleterious effects on the overall display characteristics of the device. However, a certain amount of emitted light is also absorbed by the filter, thus requiring an increased drive current that

brightens the display, and to compensate for the absorbed emitted light and thus reducing the life of the display.

Furthermore, as known to those of skill in the art, both inorganic and organic electroluminescent devices require a passivation layer to protect the layers from moisture and oxygen, as air and water can irreparably damage these layers. A hermetic seal is generally required, as taught in, for example, United States patent 5,811,177. However, the inclusion of such a hermetic seal does not generally improve the contrast ratio and other visual characteristics of the display.

DISCLOSURE OF THE INVENTION

It is therefore an object of the present invention to provide a novel electroluminescent device which obviates or mitigates at least one of the disadvantages of the prior art.

It is another object of the present invention to provide a novel kit for retrofitting an electroluminescent device.

It is yet another object of the present invention to provide a method of fabricating an electroluminescent device.

Accordingly, in one of its aspects, the present invention provides an electroluminescent device for displaying an image to a viewer in front of said device, comprising:

a front electrode substantially transparent to electroluminescent light;

a rear electrode substantially transparent to ambient light;

an electroluminescent layer (e.g., comprising an organic material such as a polymer or a small molecule) disposed between said electrodes; and

an optical interference member for passivating said electroluminescent device and for reducing the reflectance of said ambient light towards said viewer, said member disposed behind said rear electrode.

In another of its aspects, the present invention provides a kit for retrofitting onto an electroluminescent device having a front electrode substantially transparent to electroluminescent light, a rear electrode substantially transparent to ambient light, and an electroluminescent layer disposed between said electrodes, said kit comprising:

an optical interference member formed on a substrate, such that when said optical interference member is affixed behind said rear electrode the reflectance of ambient light towards a viewer is reduced and said device is passivated.

In yet another of its aspects, the present invention provides a method of fabricating an electroluminescent device for displaying an image to a viewer in front of said device, comprising the steps of:

depositing a substantially transparent front electrode onto a substantially transparent substrate;

depositing an electroluminescent layer onto said substrate such that said front electrode is intermediate said electroluminescent layer and said substrate;

depositing a substantially transparent rear electrode onto said substrate such that said front electrode and said electroluminescent layer are intermediate said rear electrode and said front electrode; and,

affixing an optical interference member behind said rear electrode, said optical interference member for passivating said electroluminescent device and for reducing the ambient light reflected towards said viewer.

In yet another of its aspects, the present invention provides an electroluminescent device comprising a front electorde, a rear electrode and a passivating layer, wherein the passivating layer comprises a malleable gel material.

Thus, in one of its preferred aspects, the present invention provides a transparent electroluminescent device having an optical interference member which reduces the overall reflectance from the device. The optical interference member is formed on a substrate, typically comprising a reflective layer, a transparent layer, a semi-transparent layer and an anti-reflective coating. The optical interference member can then be affixed behind the electroluminescent display with a transparent rear electrode. When affixed, the optical interference member can reduce reflectance from ambient light and serve as a passivation layer that protects the elements of the electroluminescent device from exposure to external elements. The optical interference member can increase the reflectance of infra-red ambient light, compared to absorbing films, to thus reduce the overall heating of the display. Furthermore, the optical interference member

can absorb light emitted towards the back of the display from the electroluminescent layer, thus reducing pixel blooming and improving the overall characteristics of the device. In another embodiment of the invention, the passivation layer can be added without the optical interference layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of a cross-section of a portion of an electroluminescent device in accordance with a first embodiment of the invention, showing an optical interference member exploded therefrom;

Figure 2 is a schematic diagram of a rear view of the optical interference member of Figure 1 having two holes formed therein;

Figure 3 is a schematic cross-sectional view of the optical interference member of Figure 2 placed in a stand used in the preparation of the optical interference member for assembly with the display of Figure 1;

Figure 4 is the schematic cross-sectional view of Figure 3 showing a tube inserted into one of the holes of the optical interference member;

Figure 5 is the schematic cross-sectional view of Figure 4 showing a bead of epoxy deposited about the periphery of the tube;

Figure 6 is a schematic end view of the optical interference member of Figure 5 showing a second tube affixed into the second hole with a bead of epoxy;

Figure 7 is a schematic front view of the optical interference member of Figure 2 having a spacer placed about the periphery;

Figure 8 is a schematic end view of the optical interference member of Figure 7;

Figure 9 is a schematic end view of the optical interference member of Figure 8 being applied to the display of Figure 1;

Figure 10 is a schematic end view of the assembled device shown in Figure 9 having a bead of epoxy applied to the exterior periphery of the spacer;

Figure 11 is an end view of the cavity in the device of Figure 10 being filled with a passivating gel;

Figure 12 is a schematic diagram of a cross-section of through a portion of an electroluminescent device in accordance with another embodiment of the invention, showing an optical interference member exploded therefrom;

Figure 13 is a schematic diagram of a cross-section of through a portion of an electroluminescent device in accordance with another embodiment of the invention, showing a passivating optical interference member exploded therefrom; and

Figure 14 is a schematic diagram of a cross-section of through a portion of an electroluminescent device in accordance with another embodiment of the invention, showing a sealing member exploded therefrom.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to Figure 1, an electroluminescent device in accordance with a first embodiment of the invention is indicated generally at 30. Device 30 comprises an electroluminescent display 31 and an optical interference member 50. Electroluminescent display 31 includes a transmitting substrate 32, a transmitting front electrode 34 disposed behind substrate 32, an electroluminescent layer 36 disposed behind electrode 34, and an ambient light transmitting rear electrode 38 disposed behind electroluminescent layer 36. Display 31 is connected to a power supply 40 via front electrode 34 and rear electrode 38 in order to drive a current through electroluminescent layer 36, and causing light L_{em} to be emitted through electrode 34 and substrate 32 and towards a viewer in front of device 30.

Transmitting substrate 32 is made from any suitable material which is transparent to at least a portion of emitted electroluminescent light, such as glass or plastic. A presently preferred material is glass having a thickness of from about 0.5mm to about 5mm. More preferably the glass has a thickness of from about 0.7mm to about 2mm. However, it is presently preferred that the glass has a thickness of about 1.1 mm. A suitable source for such glass is Corning Part #1737F available from Corning Inc. Advanced Display Products, Corning, New

York, 14831. However persons of skill in the art can choose other appropriate materials and thicknesses.

Transmitting electrode34 is any conducting material which is transparent to at least a portion of emitted electroluminescent light, such as indium tin oxide (ITO) or zinc oxide (ZnO). In a present embodiment, where electrode 34 is a layer of indium tin oxide, a presently preferred thickness is about fifteen-hundred angstroms (1500Å).

It is to be understood that electroluminescent transmitting electrode 34 can have different thicknesses, and can be in the range of, for example, from about one-thousand angstroms (1000Å) to about three-thousand angstroms (3000Å), or from about twelve-hundred angstroms (1200Å) to about two-thousand angstroms (2000Å).

Electroluminescent layer 36 can be either an inorganic or organic electroluminescent material. Suitable inorganic materials include ZnS:Mn (Zinc Sulfide doped with Manganese). Other suitable inorganic materials include ZnS:Ho, ZnS:Tb, ZnS:Tr, ZnS:Ag, ZnS:Cu, SrS:Ce, StS:Cu, StS:Cu,Ag. Other multiply-combined dopants or stacked materials will occur to those of skill in the art and as desired to provide different display characteristics, such as colour. (A discussion on such materials can be found in, for example, P.D. Rack, P.H. Holloway, "The Structure, Device Physics, and Material Properties, of Thin Film Electroluminescent Displays." *Materials Science and Engineering R21 (1998)*, 171-219.)

It will be understood that where layer 36 is an inorganic material, then power supply 40 will typically be an alternating current voltage source, and layer 36 will typically be sandwiched between dielectric layers (not shown) that stabilize layer 36 from electrical breakdown. Suitable dielectric materials can include, for example, Al_2O_3, SiO_2, SiON, SiAlON. Other dielectrics will occur to those of skill in the art.

Suitable organic materials include tris(8-hydroxyquinoline aluminum) (Alq3) or poly para phenylene vinylene (PPV). As known by those of skill in the art, photons of light from organic electroluminescent displays are emitted when electrons drop from a lowest unoccupied molecular orbital ("LUMO") of layer

36, where they combine with holes in the highest occupied molecular orbital ("HOMO") of layer 36. Accordingly, a current flow through an organic electroluminescent layer 36 can produce an emission of light. In a present embodiment, layer 36 is organic, preferably made from tris(8-hydroxyquinoline aluminum) and having a thickness of about five-hundred angstroms (500Å), although those of skill in the art will be able to select other appropriate materials and thicknesses of this layer. Where layer 36 is an organic material, then power supply 40 will typically be a constant current source, the polarity of such a current source corresponding to which of electrode 34 and electrode 36 is the cathode and the anode. It will be further apparent to those of skill in the art that the work functions of the cathode and the anode are generally chosen to substantially equal the respective LUMO and HOMO energies levels of organic electroluminescent layer 36.

While not always required, it is presently preferred that, where electroluminescent layer 36 is organic, then an electron transport layer will be situated between electroluminescent layer 36 and the cathode of display 31 and/or a hole transport layer will be situated between electroluminescent layer 36 and the anode of display 31. It will be understood that the work functions of the electron transport layer and the hole transport layer will accordingly be chosen to substantially equal the LUMO and HOMO energy levels of layer 36, respectively. Where electroluminescent layer 36 is made from Alq3, then it is generally preferred that a hole transport layer be situated between layer 36 and the anode of display 31. A suitable material for hole transport layer is NPD having a thickness of about 500Å.. Other suitable materials, for both hole transport layers and electron transport layers include α-NPD, NPB and TPD. Typical thickness can be from about 300Å to about 700Å. Other suitable materials and thickness will occur to those of skill in the art. A discussion of such structures can be found in, for example, H. Nakamura et al, "Late-News Paper: Simple Structures for Blue OLED", 1999, *SID 99 Digest*, p. 446.

Rear electrode 38 is preferably made from a conducting material that is at least partially transparent to ambient light L_{amb} incident upon substrate 32 and passing through device 30. Suitable conducting materials include aluminum or

indium tin oxide. A presently preferred material is indium tin oxide. The indium tin oxide can have a thickness of from about 500Å to about 2000Å. A presently preferred thickness is about 1000Å. As known to those of skill in the art, in the case of organic displays it is generally preferred to include a thin layer of a low work function material, such as a suitable metal, as part of the rear electrode. However, it will occur to those of skill in the art that other suitable materials and thicknesses can be chosen and used, and such variations are within the scope of the invention.

In the present embodiment, layers 34, 36 and 38 are successively vacuum deposited onto substrate 32. Where layer 36 is inorganic, the previously-described dielectric layers would also be deposited in their appropriate sequence. Similarly, where layer 36 is organic, the previously-described electron transport layer and hole transport layer would also be deposited in their appropriate sequence. Collectively, layers 32, 34, 36, and 38 compose electroluminescent display 31. Other suitable substrates and means of fabricating display 31 will occur to those of skill in the art. For example, where electroluminescent layer 36 is PPV, then spin-coating can be an appropriate fabrication technique for layer 36.

Device 30 also includes an optical interference member 50 which is attachable behind rear electrode 38 . The details of the attachment will be discussed in greater detail below.

In a present embodiment, optical interference member 50 is separately formed for attachment to display 31 behind rear electrode 38. Optical interference member 50 comprises an anti-reflective coating layer 54 of silicon dioxide, having a thickness of about nine-hundred-and-fifty angstroms (950Å). A semi-absorbent layer 58 is disposed behind anti-reflective coating layer 54. Semi-absorbent layer 58 is partially reflective, partially absorbing and partially transmissive of light in the visible spectrum, and in a present embodiment, is made from Inconel having a thickness of about one-hundred angstroms (100Å). Other suitable materials can include Nickel (Ni), Titanium, or a suitable organic material and appropriate thicknesses of such layers can be determined by those of skill in the art.

The extinction coefficient of the material and its thickness should be selected so that the reflection from layer 58 at a preselected wavelength, neglecting optical interference, should preferably be at least about thirty-five percent, with the remainder of light energy being absorbed and dissipated in the form of heat. Similarly, transmission through layer 58 at a preselected wavelength, neglecting optical interference, will preferably be at least about thirty-five percent.

It is to be understood that the extinction coefficient of layer 58 and its thickness can be selected so that the transmission through layer 58 at a preselected wavelength, neglecting optical interference, can be from about thirty percent to about forty percent. Overall, the amount of light transmitted through layer 58, after two passes, should be substantially equal to the amount of light that is originally reflected from layer 58, in order to achieve the appropriate destructive interference at the reflective surface of layer 58, as will be understood by those of skill in the art.

A substantially transparent layer 62 is disposed behind layer 58. Substantially transparent layer 62 is made from silicon dioxide (SiO_2) having a thickness of about seven-hundred-and-fifty angstroms (750Å). Other suitable layer thicknesses can be used as will occur to those of skill in the art. Other suitable materials include, for example, Silicon Nitride (Si_2N_3) and zinc oxide (ZnO). The extinction coefficient of the material of layer 62 and its thickness is selected so that the transmission through layer 62 at a preselected wavelength, neglecting optical interference, is greater than about eighty percent, but is preferably at least about ninety percent. As known to those of skill in the art, it is generally preferred that the preselected wavelength(s) for layer 62 should be substantially equal to the preselected wavelengths used to choose layer 58.

A reflective layer 66 is disposed behind layer 62. Reflective layer 66 is preferably made from aluminum and has a thickness of about fifteen-hundred angstroms (1500Å). Other suitable materials and thickness will occur to those of skill in the art.

Finally, a substrate 70, made from a material such as glass or plastic is disposed behind reflective layer 66. As will now be apparent, member 50 is

formed by successively depositing layers 66, 62, 68 and 64 onto substrate 70 using a technique such as vacuum deposition.

A wavelength of about five-hundred-and-fifty-five nanometers (555nm), substantially at the centre of the spectrum of visible light, is a presently preferred preselected wavelength used for the purpose of determining appropriate thicknesses and materials of layers member 50, as the assembled device 30 can have the desired optical interference characteristics across the visible light spectrum. As will be understood by those of skill in the art, an incidental benefit to the selection of this wavelength can result in a device which reflects electromagnetic energy outside the visible spectrum, including infra-red, thus reducing the heating of the display. However, it will occur to those of skill in the art that other wavelengths can be selected, as desired.

Member 50 can be assembled onto display 31 using techniques known in the art. However, a presently preferred and novel method of assembly is as follows. As shown in Figure 2, member 50 includes two holes 80, 82, about 1/8" inches in diameter. Holes 80, 82 are preferably formed in substrate 70 prior to the deposition of the layers 66, 62, 58 and 54 thereon, and during deposition, holes 80, 82 remain unoccluded. Referring now to Figure 3 member 50 is placed over a template 84 having a hole 86 which is aligned with hole 80. Template 84 is preferably a clean piece of glass positioned in a tray 88 in sized to snugly retain template 84 therein. (Together, template 84 and tray 88 compose a stand.) Next, a guide-wire 90 or wire-stand or wire-rack is placed through holes 80 and 86 so that it rests on the bottom of tray 88.

Referring now to Figure 4, a tube 92 made from vinyl, having a length of about three inches and an external diameter smaller than the diameter of hole 80 is inserted into holes 80 and 86 so that the end of tube 92 rests against the bottom of tray 88. Accordingly, the thickness of template 84 determines the length of tube 92 that extends past optical interference layer 54.

Referring now to Figure 5, a small bead of epoxy 94 is placed about the periphery of tube 92 at the junction thereof and the periphery of hole 80 to form seal and affix tube 92 in hole 80. A presently preferred epoxy is Dymax UV curing epoxy Part Number 9005, 51 Greenwoods Road, Torrington, CT, 06790,

USA but other sealants will occur to those of skill in the art. The bead of epoxy 94 is then exposed to ultraviolet light in order to cure the epoxy. The foregoing steps are repeated, or performed simultaneously, to seal and affix a second tube 96 within hole 82, as shown in Figure 6.

In an alternative embodiment, tubes 92, 96 have the same inner diameter as holes 80, 82, respectively, and are affixed thereto by placing a bead of epoxy around the base of tubes 92, 96 when they abut the periphery of their respective holes 80, 82. In this alternative embodiment, template 84 can be eliminated.

Next, the mating surfaces of electrode 38 and substrate 54 are prepared by applying a primer to each respective surface. A suitable primer is Primer 94 available from 3M Canada, 155 Les Mill Road, North York, Ontario, M3B 2T8, Canada. The mating surfaces of electrode 38 and substrate 54 are then allowed to dry, usually for a period of about five minutes. Compressed nitrogen can be used to clean both of the mating surfaces.

Referring now to Figures 7 and 8, spacer 44 is then applied about the periphery of the front face of substrate 54, as best seen in Figure 3. It is presently preferred that spacer 44 is a double-sided tape sold as 3M-Scotch Part Number 4929 also available from 3M Canada. This tape can be trimmed on a clean surface using a stainless steel knife. A presently preferred width of tape is less than about 1.6 millimeters however, other widths can be chosen as desired. As shown in Figure 8, the thickness of spacer 44 is preferably about 0.05 inches. (In a present embodiment, spacer 44 is slightly ticker than template 84, and thus the thickness of spacer 44 can be used to determine an appropriate thickness for template 84).

Next, the protective backing on spacer 44 is removed. Next, member 50 is aligned with electrode 38 and abutted thereagainst, as shown in Figure 9. Gentle pressure can be applied around the edges of member 50 by pressing against substrate 70 to attach member 50 to electrode 38 by allowing the adhesive on spacer 44 to properly adhere itself to electrode 38.

Referring now to Figure 10, sealant 42 is place about the periphery of spacer 44. A presently preferred sealant 42 is an epoxy such as Dymax UV curing epoxy Part Number 9005. Preferably the bead of epoxy is about 1.27 millimeters

wide and is at least thick enough to cover spacer 44, but does not exceed the thickness of member 50 if it should run along the exterior thereof. It is preferable that the bead of epoxy does not contact the electrical contacts on the periphery of display 31. The epoxy can be cured by exposing it to ultraviolet light.

The cavity between electrode 38 and layer 54 is filled with a transparent passivation material such as a silicone gel or silicone oil that is transparent to ambient light. A presently preferred passivation material is a silicone gel. A presently preferred silicone gel is Part Number RTV6166, having two parts, designated as Part A and Part B, which is available from General Electric Corporation 260 Hudson River Road, Waterford, New York, NY, 12188(It is understood that other two-part silicone gels from General Electric can be used). The steps to fill the cavity with the gel are described as follows. First, a sufficient amount gel to fill the cavity is decanted into a beaker. In the present embodiment, Part A and Part B are decanted and then mixed together. Next, the beaker and the assembly of display 31 and member 50 are placed into a desiccator or vacuum chamber. The chamber is then evacuated to create a vacuum therein, preferably until an atmospheric pressure of about 30 Torr is reached. The vacuum is maintained for about fifteen minutes to de-air the gel and desicate and the assembly of display 31 and member 50. The chamber is then vented with nitrogen.

The beaker and the assembly of display 31 and member 50 are then removed from the chamber. Next, as shown in Figure 11, a syringe is filled with the de-aired gel and then used to dispense the gel into tube 92. Dispensing is preferably performed by orienting tube 92 directly above tube 96, to allow gravity to carry the gel towards the corner proximal tube 96. During filling, tube 96 acts as a vent to allow atmosphere displaced by the gel to escape therethrough. It is generally preferred that once the gel approaches the corners, filling is stopped until the gel settles. The filling process is repeated until tube 96 is filled.

The gel is then allowed to cure for a predetermined period of time, preferably about two hours. Next, a piece of indium wire is inserted into each tube 92, 96, and using a wire rack it is pressed down upon to firmly ensure it is

flatted to the glass surface, thereby sealing the hole 80, 82 respective to each tube 92, 96.

In the alternative embodiment, where the tube is sealed in abutment with the periphery of the hole, then the tube is cut flush with the hole, and then a slide of glass is placed over the hole which is sealed with epoxy.

Each tube 92, 96 is then cut flush with substrate 70. Holes 80, 82 are then sealed, preferably by using a drop of epoxy, and then covering each hole 80, 82 with a small piece of cover glass, and then an additional bead of epoxy is placed over the glass. The freshly applied epoxy is then cured under ultra-violet light for about two minutes or any other suitable time. Excess epoxy protruding from the back of substrate 80 can be removed with a razor blade.

The operation of device 30, as fully assembled, will now be discussed. It will be appreciated by those of skill in the art that the following is a simplified model for purposes of explanation, and that other physical phenomena occurring during the operation of device 30 are assumed, for the purposes of this discussion, to have a negligible influence on the operation. Power supply 40 is 'on', so the electricity flows through electroluminescent layer 36 causing light to be emitted out through the front of device 30 through electrode 34, substrate 32 and towards a viewer, as indicated by arrow L_{em}.

At the same time, ambient light is incident upon device 30, as indicated by arrow L_{amb} and passes through substrate 32, electrode 34, electroluminescent layer 36, electrode 38, the gel filling the cavity behind electrode 38, and then through anti-reflective coating 54. Ambient light L_{amb} incident upon semi-absorbing layer 58 is partially reflected, partially absorbed and partially transmitted. The light transmitted through semi-absorbing layer 58 passes through transparent layer 62, where it reflects off reflecting layer 66 and back through transparent layer 62, at which point this reflected light is inverted one-hundred-and-eighty degrees out of phase with the partially reflected light from layer 58, and thus these two reflections destructively interfere and substantially cancel each other out. The energy otherwise found in these two reflections is absorbed by semi-absorbing layer 58 and reflective layer 66, where it is dissipated as a relatively small amount of heat. The result is that reflected light (L_{ref}) back

towards the viewer from device 30 is reduced. In a present embodiment, reflected light (L_{ref}) is reduced by about ninety percent, compared to an electroluminescent device assembled without optical interference member 50.

It is believed that in other embodiments of the invention, reflected light (L_{ref}) can be reduced by as much as about 99.5 percent by choosing different materials, thicknesses and extinction coefficients for optical interference member 50 and by selected appropriate thicknesses and materials for the other layers in device 30.

In other embodiments of the invention, optical interference member 50 can be disposed in combination with other optical interference members incorporated into device 30, such as the structures taught in U.S. Patent 5,049,780 to Dobrolowoski and/or applicant's copending application entitled "Organic Electroluminescent Device", bearing application number 09/361137, the contents of which are incorporated herein by reference.

Referring now to Figure 12, a device in accordance with a second embodiment of the invention is indicated generally at 130. Like components in device 130 to components in device 30 are indicated with the reference numbers that have been increased by a value of 100. Device 130 comprises an electroluminescent display 131 and an optical interference member 150. Electroluminescent display 131 includes an electroluminescent transmitting substrate 132, an electroluminescent transmitting front electrode 134 disposed behind substrate 132, an electroluminescent layer 136 disposed behind electrode 134, and an ambient light transmitting rear electrode 138 disposed behind electroluminescent layer 136. Display 131 is connected to a power supply 140 via front electrode 134 and rear electrode 138 in order to drive a current through electroluminescent layer 136, and causing light L_{em} to be emitted though electrode 134 and substrate 132 and towards a viewer in front of device 130. As will now be apparent to those of skill in the art, display 131 is substantially the same as display 31, and accordingly, the same discussions apply to display 131.

Device 130 also includes an optical interference member 150 which is attachable behind rear electrode 138 . In a present embodiment, optical interference member 150 is separately formed for attachment to display 131

behind rear electrode 138. Optical interference member 150 comprises an anti-reflective coating layer 154 of silicon dioxide, having a thickness of about nine-hundred-and-fifty angstroms (950Å). A substrate 170, made from a material such as glass or plastic is disposed behind ani-reflective coating layer 154.

A semi-absorbent layer 158 is disposed behind substrate 170. Semi-absorbent layer 158 is partially reflective, partially absorbing and partially transmissive of light in the visible spectrum, and in a present embodiment, is made from Inconel having a thickness of about one-hundred angstroms (100Å). Other suitable materials can include Nickel (Ni), Titanium (Ti), or a suitable organic material and appropriate thicknesses of such layers can be determined by those of skill in the art.

The extinction coefficient of the material and its thickness should be selected so that the reflection from layer 158 at a preselected wavelength, neglecting optical interference, should preferably be at least about thirty-five percent, with the remainder of light energy being absorbed and dissipated in the form of heat. Similarly, transmission through layer 158 at a preselected wavelength, neglecting optical interference, will preferably be at least about thirty-five percent.

It is to be understood that the extinction coefficient of layer 158 and its thickness can be selected so that the transmission through layer 158 at a preselected wavelength, neglecting optical interference, can be from about thirty percent to about forty percent. Overall, the amount of light transmitted through layer 158, after two passes, should be substantially equal to the amount of light that is originally reflected from layer 158, in order to achieve the appropriate destructive interference at the reflective surface of layer 158, as will be understood by those of skill in the art.

A substantially transparent layer 162 is disposed behind layer 158. Substantially transparent layer 162 is made from silicon dioxide (SiO_2) having a thickness of about seven-hundred-and-fifty angstroms (750Å). Other suitable materials and layer thicknesses can be used as will occur to those of skill in the art, such as Si_2N_3 and ZnO. The extinction coefficient of the material of layer 162 and its thickness is selected so that the transmission through layer 162 at a

preselected wavelength, neglecting optical interference, is greater than about eighty percent, but is preferably at least about ninety percent. As known to those of skill in the art, it is generally preferred that the preselected wavelength(s) for layer 162 should be substantially equal to the preselected wavelengths used to choose layer 158.

A reflective layer 166 is disposed behind layer 162. Reflective layer 166 is preferably made from aluminum and has a thickness of about fifteen-hundred angstroms (1500Å). Other suitable materials and thickness will occur to those of skill in the art.

As will now be apparent, member 150 is formed by successively depositing layer 154 on a first side of substrate 170 and successively depositing layers 158, 162 and 166 on the opposite side of substrate 170 using a technique such as vacuum deposition.

As will now be apparent to those of skill in the art, the assembly of optical interference member 150 to device 131 is substantially the same as previously described for device 30. Similarly, the variations of structure, assembly and operation of device 30 are also applicable to device 130 with appropriate modifications.

Referring now to Figure 13, a device in accordance with a second embodiment of the invention is indicated generally at 230. Like components in device 230 to components in device 30 are indicated with the reference numbers that have been increased by a value of 200. Device 230 comprises an electroluminescent display 231 and an optical interference member 250. Electroluminescent display 231 includes an electroluminescent transmitting substrate 232, an electroluminescent transmitting front electrode 234 disposed behind substrate 232, an electroluminescent layer 236 disposed behind electrode 234, and an ambient light transmitting rear electrode 238 disposed behind electroluminescent layer 236. Display 231 is connected to a power supply 240 via front electrode 234 and rear electrode 238 in order to drive a current through electroluminescent layer 236, and causing light L_{em} to be emitted though electrode 234 and substrate 232 and towards a viewer in front of device 230. As will now be apparent to those of skill in the art, display 231 is substantially the

same as display 31, and accordingly, the same discussions substantially apply to display 231.

Device 230 also includes a passivating optical interference member 250 which is attachable behind rear electrode 238. Optical interference member 250 comprises a passivation layer 280, which in a present embodiment is layer 154 of silicon dioxide (SiO_2), having a thickness of from about 500Å to about 2000Å. More preferably, layer 154 can be from 750Å about 1250Å. It is presently preferred, however, that layer 154 is about 1000Å.

A semi-absorbent layer 258 is disposed behind passivation layer 280. Semi-absorbent layer 258 is partially reflective, partially absorbing and partially transmissive of light in the visible spectrum, and in a present embodiment, is made from Inconel having a thickness of about one-hundred angstroms (100Å). Other suitable materials can include Nickel (Ni), Titanium (Ti), or a suitable organic material and appropriate thicknesses of such layers can be determined by those of skill in the art.

The extinction coefficient of the material and its thickness should be selected so that the reflection from layer 258 at a preselected wavelength, neglecting optical interference, should preferably be at least about thirty-five percent, with the remainder of light energy being absorbed and dissipated in the form of heat. Similarly, transmission through layer 258 at a preselected wavelength, neglecting optical interference, will preferably be at least about thirty-five percent.

It is to be understood that the extinction coefficient of layer 258 and its thickness can be selected so that the transmission through layer 258 at a preselected wavelength, neglecting optical interference, can be from about thirty percent to about forty percent. Overall, the amount of light transmitted through layer 258, after two passes, should be substantially equal to the amount of light that is originally reflected from layer 258, in order to achieve the appropriate destructive interference at the reflective surface of layer 258, as will be understood by those of skill in the art.

A substantially transparent layer 262 is disposed behind layer 258. Substantially transparent layer 262 is made from silicon dioxide (SiO_2) having a

thickness of about seven-hundred-and-fifty angstroms (750Å). Other suitable materials and layer thicknesses can be used as will occur to those of skill in the art, such as Si_2N_3 and ZnO. The extinction coefficient of the material of layer 262 and its thickness is selected so that the transmission through layer 262 at a preselected wavelength, neglecting optical interference, is greater than about eighty percent, but is preferably at least about ninety percent. As known to those of skill in the art, it is generally preferred that the preselected wavelength(s) for layer 262 should be substantially equal to the preselected wavelengths used to choose layer 258.

A reflective layer 266 is disposed behind layer 262. Reflective layer 266 is preferably made from aluminum and has a thickness of about fifteen-hundred angstroms (1500Å). Other suitable materials and thickness will occur to those of skill in the art.

As will now be apparent, member 250 is formed by successively depositing layers 280, 258, 262 and 266 onto electrode 238, using a technique such as vacuum deposition. In a present embodiment, layers 280, 258, 262, 266 of optical interference member 250 are successively deposited behind rear electrode 238. It is contemplated that such deposition can be performed as part of the deposition required to build display 231, or the deposition can be performed as a completely separate stage of the assembly of device 230. For example, display 231 can be formed and then packaged in a sealed chamber for shipping to another location, where display 231 can then be removed and at which point optical interference member 250 can be formed thereon.

As will now be apparent to those of skill in the art, the operation of device 230 is substantially the same as previously described for device 30. Similarly, the variations of structure and operation of device 30 are also applicable to device 230 with appropriate modifications. It is believed that in the present embodiment however, up to about 95% of unwanted ambient light reflection is eliminated.

In a variation of device 230, passivation layer 280 can be eliminated where the patterning, materials and thicknesses chosen for optical interference member 250 correspond to the electrical properties of electrode 238, and accordingly optical interference member 250 can thus form part of the electrical

circuit that power electroluminescent layer 236. Other variations will occur to those of skill in the art.

Referring now to Figure 13, a device in accordance with another embodiment of the invention is indicated generally at 330. Like components in device 330 to components in device 30 are indicated with the reference numbers that have been increased by a value of 300. Device 330 comprises an electroluminescent display 331 and an optical interference member 350. Electroluminescent display 331 includes an electroluminescent transmitting substrate 332, an electroluminescent transmitting front electrode 334 disposed behind substrate 332, an electroluminescent layer 336 disposed behind electrode 334, and a rear electrode 338 disposed behind electroluminescent layer 236. Display 331 is connected to a power supply 340 via front electrode 334 and rear electrode 338 in order to drive a current through electroluminescent layer 336, and causing light L_{em} to be emitted though electrode 334 and substrate 332 and towards a viewer in front of device 330. As will now be apparent to those of skill in the art, display 331 is substantially the same as display 31, and accordingly, the same discussions substantially apply to display 331. However, in addition to the previously described variations on display 31, display 331 can have a rear electrode 338 that is either transparent or reflective.

Sealing member 351 is a separate attachment to display 331 behind rear electrode 338. In a present embodiment, sealing member 351 comprises a substrate 370, made from a material such as glass or plastic. Sealing member 351 is assembled onto display 331 in substantially the same manner that optical interference member 50 is assembled to display 31 in device 30. In particular aspect of the present embodiment, a gel is used to fill the cavity between member 351 and electrode 338 and act as a passivating layer for electrode 338. It will now be apparent that, while sealing member 351 does not have the same contrast enhancement features of the previous embodiments, it retains a passivation layer of gel for display 331.

While only specific combinations of the various features and components of the present invention have been discussed herein, it will be apparent to those of skill in the art that desired sub-sets of the disclosed features and components

and/or alternative combinations of these features and components can be utilized, as desired. For example, the embodiments discussed herein can be combined to provide multiple optical interference members disposed between different layers of the electroluminescent device, and therefore disjoined from each other, in order to further reduce reflectance from the device.

Furthermore, the optical interference members described in the embodiments herein can simply be a transparent layer instead of a combination of a transparent layer and a semi-absorbing layer in order to achieve different results, and it will be apparent that these different types of optical interference members can also be placed at different locations throughout the device.

The present invention can be suitable for a computer display. For example, a pixellated electroluminescent computer display can be formed where the front electrode comprises a plurality of generally parallel and spaced electrodes to compose the front layer of an electroluminescent computer display, and the rear electrode comprises a number of spaced cathodes which are generally perpendicular to the front electrodes. It will be further understood that the electrodes can be patterned in a variety of ways, other than pixellated, to create different recognizable patterns to a user of device 10. When such a display has an organic electroluminescent layer and is pixellated or patterned, it will be appreciated that individual pixels or patterns can be fired using known techniques such as pulsed-DC, and/or adding a periodic reverse-polarity 'refresh' pulse to reduce built-up charge. The device can also be hybrid-display having an active matrix, as can be found in notebook computers.

In addition, the present invention can be suitably modified for use in colour electroluminescent devices. As known to those of skill in the art, multi-colour and full-colour devices can be formed from stacked transparent organic electroluminescent layers. Multi-coloured and full-coloured devices can also be provided through a patterned red-green-blue organic layer (i.e. by selecting materials having inherent colour properties, or by appropriately doping the patterns on the layer). Other colourizing techniques can including the use of a white-emitter and appropriate filters. Alternatively, a blue emitter in combination with colour-change materials can be used. It will be apparent that the teachings

of the present invention can be modified to accommodate these and other colour devices.

The present invention can be suitable for use as a backlight for a liquid crystal display, having the optical interference member disposed therebehind.

The present invention provides a novel electroluminescent device having an optical interference member which reduces the overall reflectance from the device. The optical interference member is provided in the form of a kit that can be retrofitted onto the back of an existing electroluminescent device. When affixed, the kit can provide reduce reflectance from ambient light and serve as a passivation layer that protects the elements of the electroluminescent device from exposure to external elements. Preferably, the components of the optical interference member are selected to have a thickness which causes at least some destructive optical interference of ambient light incident on the electroluminescent display. Finally, in embodiments where a semi-absorbent layer and transparent layer are combined to form the optical interference member, then placement of such an optical interference member can actually increase the reflectance of infra-red ambient signatures, compared to absorbing films, thus reducing the heating of the display and reducing the likelihood of damage to the electroluminescent layer.

While the present invention has been described with reference to preferred and specifically illustrated embodiments, it will of course be understood by those skilled in the arts that various modifications to these preferred and illustrated embodiments may be made without departing from the spirit and scope of the invention.

All publications, patents and patent applications referred to herein are incorporated by reference in their entirety to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated by reference in its entirety.

What is claimed is:

1. An electroluminescent device for displaying an image to a viewer in front of said device, comprising:

a front electrode substantially transparent to electroluminescent light;

a rear electrode substantially transparent to ambient light;

an electroluminescent layer disposed between said electrodes; and

an optical interference member for passivating said electroluminescent device and for reducing the reflectance of said ambient light towards said viewer, said member disposed behind said rear electrode.

2. The electroluminescent device defined in claim 1, wherein the electroluminescent layer comprises an organic material.

3. The electroluminescent device defined in claim 1, wherein the electroluminescent layer comprises an inorganic phosphor.

4. A kit for retrofitting onto an electroluminescent device having a front electrode substantially transparent to electroluminescent light, a rear electrode substantially transparent to ambient light, and an electroluminescent layer disposed between said electrodes, said kit comprising:

an optical interference member formed on a substrate, such that when said optical interference member is affixed behind said rear electrode the reflectance of ambient light towards a viewer is reduced and said device is passivated.

5. The kit defined in claim 4, further comprising an anti-reflective layer formed on said optical interference member.

6. The kit defined in claim 4, wherein said optical interference member comprises a semi-absorbent layer, a transparent layer and a reflecting layer.

7. The kit defined in claim 4, wherein said electroluminescent layer is tris(8-hydroxyquinoline aluminum).

8. The kit defined in claim 4, wherein said electroluminescent layer is doped tris (8 hydroxyquinoline aluminum).

9. The kit defined in claim 4, including an additional optical interference member between said electroluminescent layer and said rear electrode.

10. The kit defined in claim 4, wherein said optical interference member comprises a transparent layer.

11. The kit defined in claim 4, wherein said electroluminescent layer is polymer-based.

12. The kit defined in claim 4, including a spacer for placement intermediate said rear electrode and said optical interference member and a two part transparent silicone-gel for filling a cavity between said rear electrode and said optical interference member when said rear electrode, said spacer and said optical interference member are assembled.

13. A method of fabricating an electroluminescent device for displaying an image to a viewer in front of said device, comprising the steps of:

depositing a substantially transparent front electrode onto a substantially transparent substrate;

depositing an electroluminescent layer onto said substrate such that said front electrode is intermediate said electroluminescent layer and said substrate;

depositing a substantially transparent rear electrode onto said substrate such that said front electrode and said electroluminescent layer are intermediate said rear electrode and said front electrode; and,

affixing an optical interference member behind said rear electrode, said optical interference member for passivating said electroluminescent device and for reducing the ambient light reflected towards said viewer.

14. The method defined in claim 13, wherein said step of affixing comprises the steps of depositing said optical interference member using vacuum deposition.

15. The method defined in claim 13, wherein said optical interference member includes a semi-absorbent layer, a substantially transparent layer and a reflecting layer.

16. The method defined in claim 13, wherein said step of affixing comprises the steps of:

attaching a spacer to said rear electrode;

attaching said optical interference member to said rear electrode; and

filling a cavity intermediate said optical interference member and said electrode with a substantially transparent passivation material.

17. The method defined in claim 16, wherein said passivation material is a silicone-gel.

18. The method defined in claim 16, wherein said gel is a two-part silicone-gel.

19. The method defined in claim 17, wherein said gel is substantially the same as Part Number RTV6166 of General Electric Corporation.

20. The use of an silicone gel intermediate a passivating layer and a rear electrode of an electroluminescent device.

21. An electroluminescent device comprising a front electorde, a rear electrode and a passivating layer, wherein the passivating layer comprises a malleable gel material.

22. The electroluminescent device defined in claim 21, wherein the passivating material comprises a silicone gel.

23. The electroluminescent device defined in claim 22, wherein the silicone gel is derived from a first liquid reactant and a second liquid reactant which, when combined, cure to form the silicone gel.

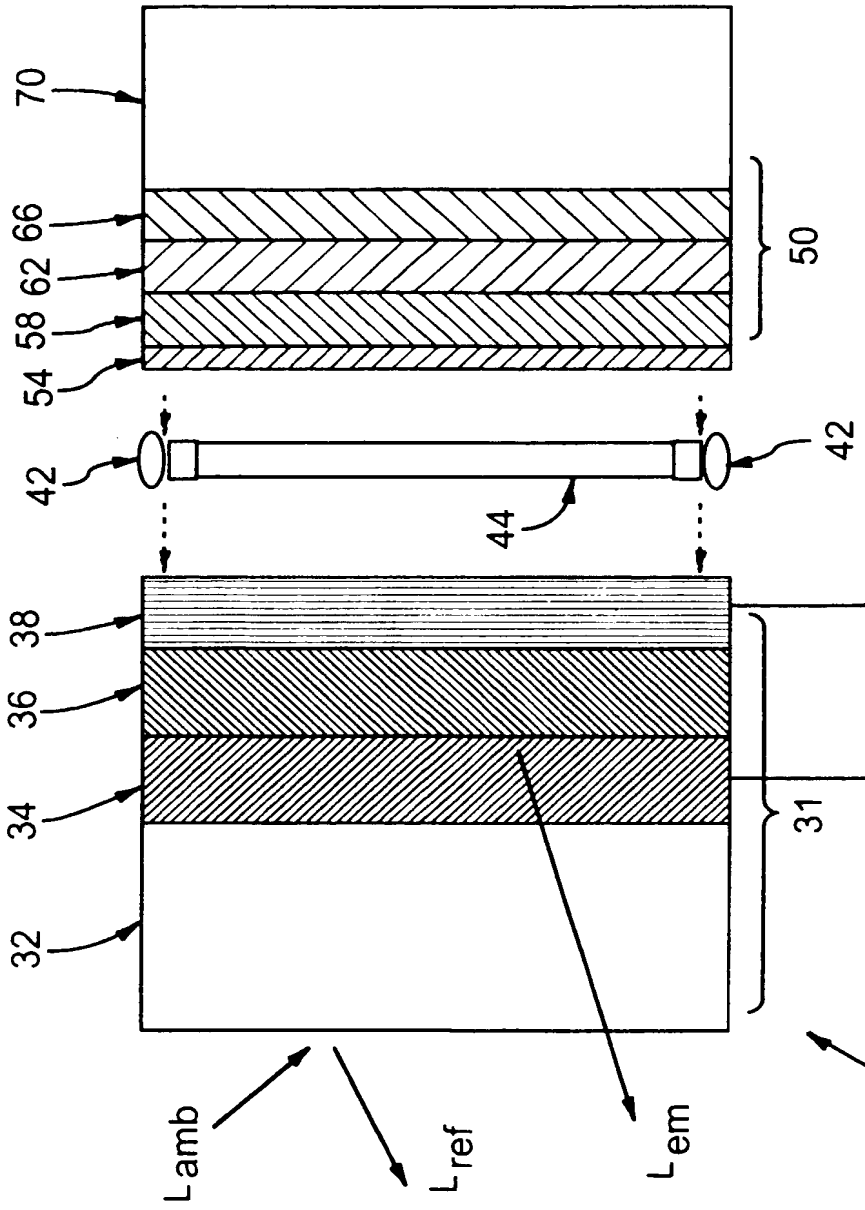


FIG.1

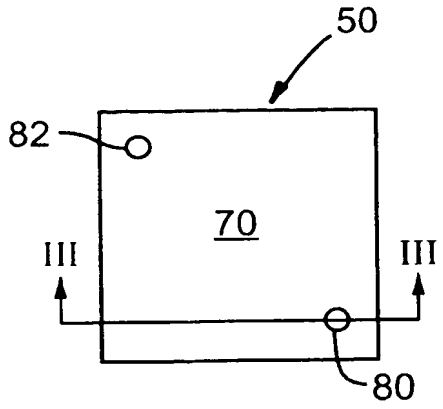


FIG.2

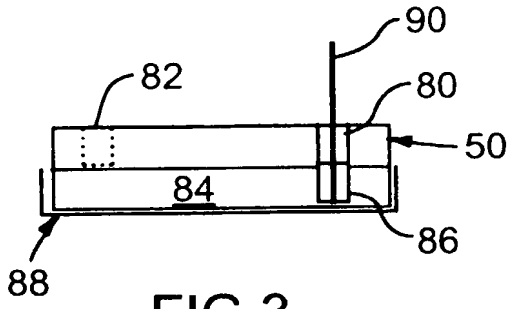


FIG.3

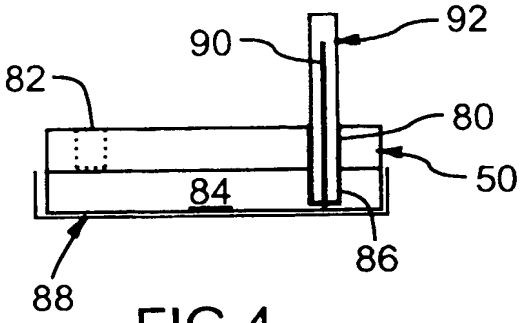


FIG.4

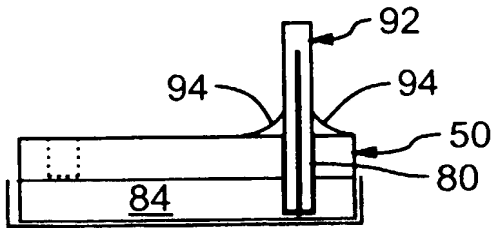


FIG.5

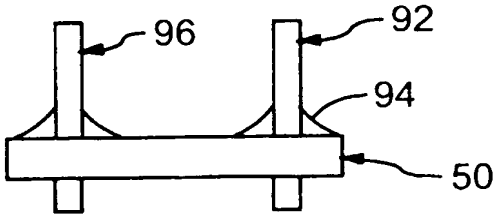


FIG.6

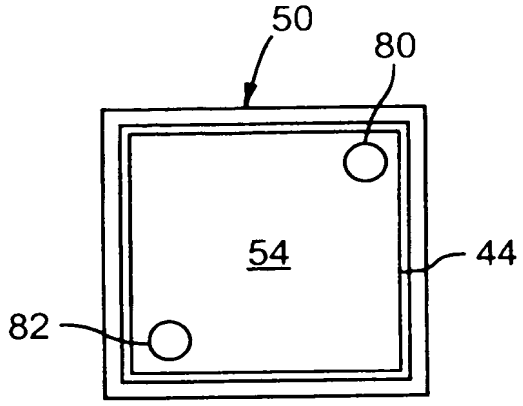


FIG.7

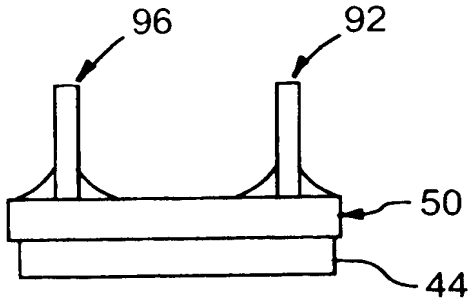


FIG.8

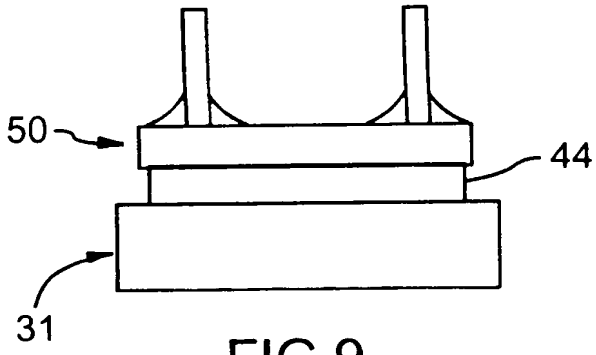


FIG.9

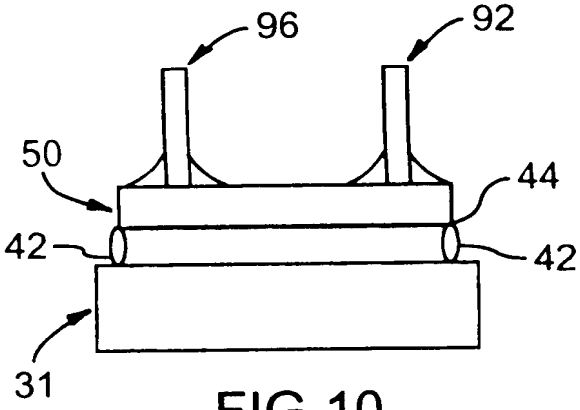


FIG.10

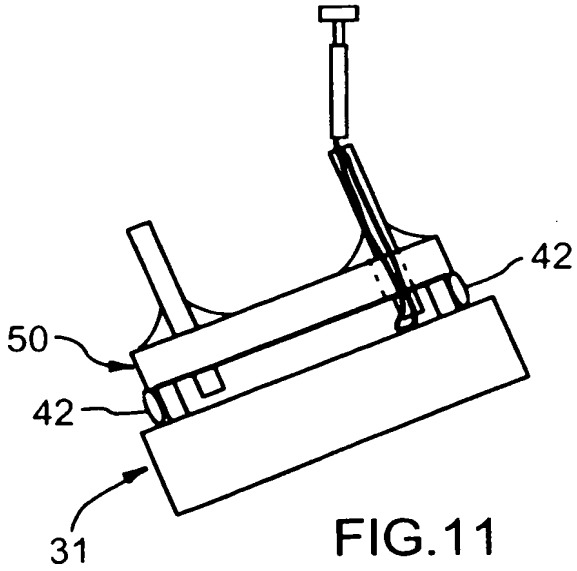
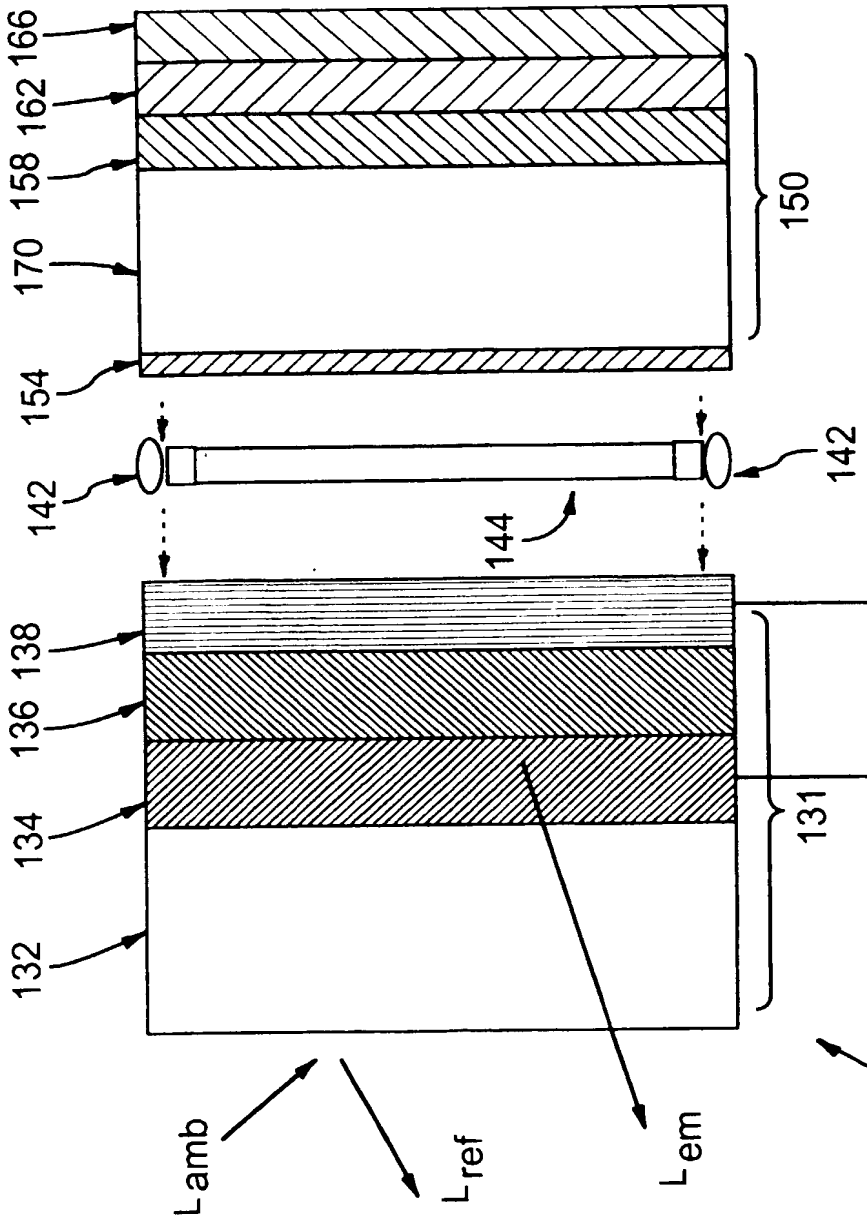


FIG.11


166
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L_{amb}
L_{ref}
L_{em}

FIG.12

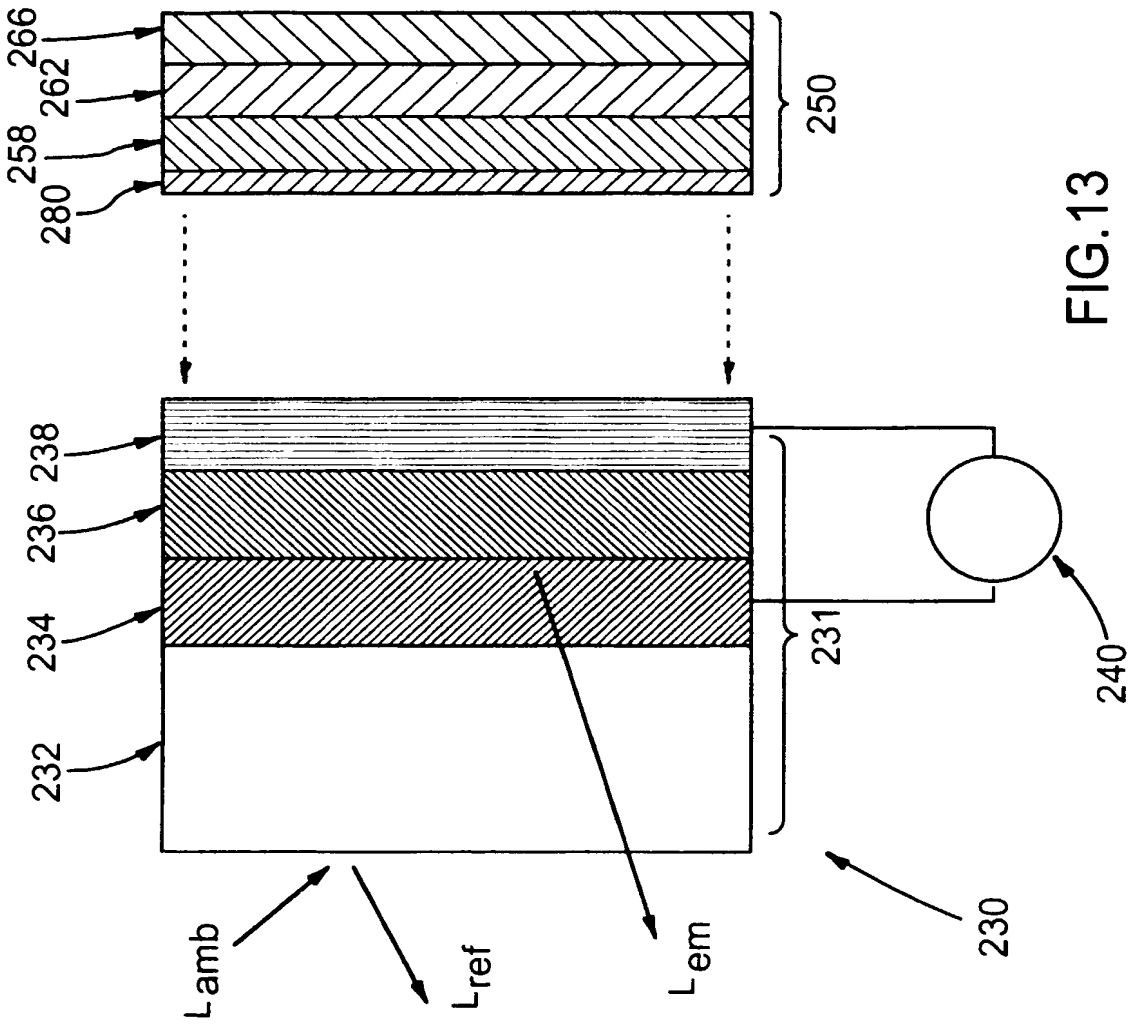

FIG.13

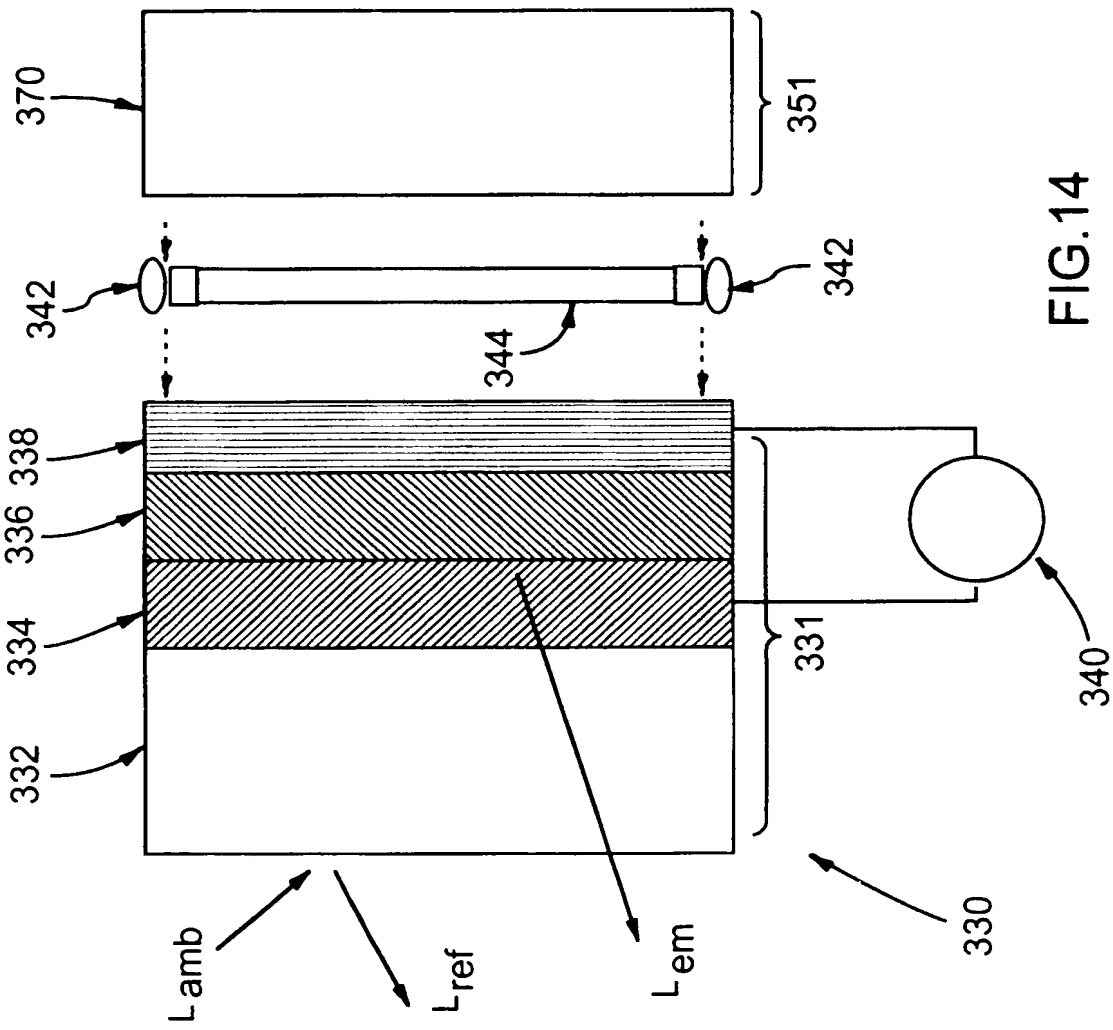

FIG.14

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 00/00855

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05B33/22 H05B33/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 615 402 A (MATSUSHITA ELECTRIC IND CO LTD) 14 September 1994 (1994-09-14) claims 1-7 ---	1,3,13
A	EP 0 388 608 A (MATSUSHITA ELECTRIC IND CO LTD) 26 September 1990 (1990-09-26) claims 1-7 ---	1,3,13
A	GB 1 389 737 A (GEN ELECTRIC CO LTD) 9 April 1975 (1975-04-09) the whole document ---	1,3,13
A	PATENT ABSTRACTS OF JAPAN vol. 015, no. 442 (E-1131), 11 November 1991 (1991-11-11) & JP 03 187186 A (MATSUSHITA ELECTRIC IND CO LTD), 15 August 1991 (1991-08-15) abstract ---	1,3,13
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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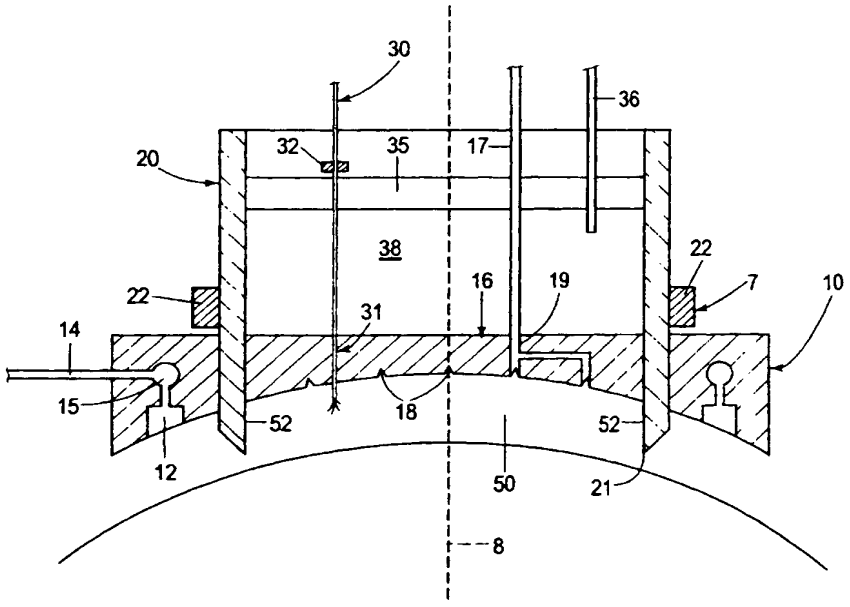
(54) Title: CORNEAL CUTTING IMPLEMENT



(57) Abstract: Apparatus for forming a corneal lenticule, includes a body (10), and means (12) to apply the body to the anterior surface of a cornea. Means (20) is carried by the body for forming a closed or nearly closed incision (52) in the surface of the cornea by cutting in a direction generally parallel to the axis of the cornea, to a predetermined depth, thereby defining a corneal segment (50) bounded laterally by the incision. Means (31) is provided to cause tissue separation in the interior of the cornea behind the segment to the incision, whereby to separate the segment as a corneal lenticule.

WO 01/05341 A1

CORNEAL CUTTING IMPLEMENT

Field of the Invention

The method and apparatus of the present invention has an application in corneal surgery where lamellar cuts of the cornea are desirable. This apparatus could be used in a number of corneal surgical applications including keratomileusis operations such as Laser in-situ Keratomileusis (LASIK) or Automated Lamellar Keratoplasty (ALK), to fashion a corneal button in corneal transplant operations or to remove specific layers of diseased corneal tissue.

Background Art

The cornea is stratified into five distinct, easily distinguished layers. The epithelium covers the outermost surface of the cornea and consists of 5 to 7 layers of fast replicating cells, which are replaced approximately every 7 days. Directly beneath the 50 micron epithelial layer is Bowman's membrane, a 10 -12 micron thick layer of dense collagenous material. The underlying stroma makes up the main body of the cornea, which is formed by layers of parallel collagen bundles. Descement's membrane and the endothelium form the internal portion of the cornea and have a role in the transport of nutrients. The epithelium and endothelium assist in maintaining the clarity of the cornea (Junqueira, Carneiro & Kelley, 1989 cited below).

Refractive surgery operations exist where it is desirable to remove small amounts of corneal tissue to effect a refractive change. In operations such as Photorefractive Keratectomy the epithelial layer is manually removed and then Bowman's membrane and part of the stroma are ablated by laser energy. However, this operation can lead to unwanted side effects, such as corneal haze, and is not suitable for higher refractive errors. A more recently developed refractive operation called LASIK maintains the integrity of the epithelial layer and Bowman's membrane (See US patent 4,903,695). A flap of tissue is displaced from the anterior cornea and a minute amount of tissue in the shape of a lens is removed from the stromal bed or from the underside of the lenticule, by way of

laser ablation (or by cutting with a second pass of a microkeratome, as in Automated Lamellar Keratoplasty). The corneal lenticule or "flap" is then replaced to its original position, creating an optical correction. This method of refractive surgery produces fewer side effects and quicker healing, as the epithelium and Bowman's membrane are left intact.

The corneal flap is usually created during LASIK or ALK with an instrument known as a microkeratome. Prior art microkeratomes, such as those described in US Patents 5,586,980 & 5,591,174, utilise an applicator shoe and a sliding blade mounted to an eye retaining ring. Suction is applied to the ring and the sliding blade is then advanced across the cornea by way of dovetailed guides. A partial thickness corneal incision is made, creating a hinged flap of tissue that can be pulled back to allow laser ablation of the stromal bed. The microkeratome assembly may be removed from the cornea before ablation takes place, or, as in US Patent 5,586,980, the assembly may be left in place on the cornea to fixate the position of the eye.

Most microkeratomes use steel or gemstone blades and a linear or rotary motion to incise the cornea. However, there are a number of inherent drawbacks in blade microkeratomes. The linear motion of the blade has the disadvantage that the corneal tissue is "bunched up" as the cut is taking place, leading to a jagged, asymmetric edge. Many commercial microkeratomes also rely on the operating surgeon to manually advance the blade across the cornea. This can lead to an irregular incision as the speed or pressure of the surgeon's hand varies. US Patent RE35421 overcomes this problem by using mechanical equipment to advance the blade automatically. However, automated microkeratomes still have the potential to cause complications. The machinery involved in such microkeratomes is very expensive to purchase and has a high risk of mechanical failure or malfunction. Common microkeratome accidents include the formation of a corneal cap (complete removal of the lenticule), an incomplete flap, uneven flap, perforation of the globe, introduction of infection, and other serious and sight threatening complications. Steel blades also need to be regularly replaced and are relatively expensive.

An alternative to blade style microkeratomes for ALK involves water jet technology, explained in US Patents 5,556,406 & 5,833,701. These patents teach the use of templates (adapted to fit varying corneal contours) that are placed on the anterior cornea to deform it to a desired planar configuration. Made of porous metal, suction is achieved with minimal vacuum strength. The template is inserted inside a vacuum-held cutting ring and a small diameter, highly pressurised jet of water is used to cut the cornea (like a blade) and form a hinged flap.

This technology avoids the mechanical problems associated with blade microkeratomes. However, water jet technology still involves a cutting or tearing action that can disrupt the structure of the cornea. Water jets are also not feasible for laser procedures. Laser ablation of the cornea is very dependent on tissue hydration levels. The cornea is sustained in a relatively dehydrated state (L.C. Junqueira, J. Carneiro & R.O. Kelley, 1989. *Basic Histology*, Appleton & Lange, Connecticut.). If corneal tissue is too hydrated during laser treatment the laser energy will be absorbed by the excess water and sub-optimal tissue ablation will occur. Inadequate tissue removal will result in less than ideal visual outcomes with the possibility of undercorrection, induced astigmatism or corneal island formation. Predictable and uniform tissue hydration is necessary during laser ablation procedures such as LASIK to avoid these problems.

Aspects of blade and waterjet microkeratomes are brought together in the arrangement of international patent publication WO 99/45867. Here, a trephine structure with an inner flat ring is used to applanate an annular zone of the cornea below which a diametrally disposed blade is rotated to form a cut to a depth determined by a depth stop. A jet of fluid, which may be a liquid or a hydrated gas, is then used to separate a flap along a lamella. The flap is said to be hinged and ablation can be effected either on the exposed corneal tissue or on the flap itself. It is thought that, in this arrangement, the flattening of the cornea involved in the applanation step gives rise to an undesirable increase in intraocular pressure beyond normal levels, which can in turn lead to the development of glaucoma and/or to disk changes in the eye. The use of a liquid jet, as primarily proposed in WO 99/45867, is subject to the potential difficulties already outlined.

The prior art technology has proven to be inadequate in providing a safe, affordable method and apparatus for making flaps on the cornea. Accordingly, the object of the present invention is to provide a relatively safer, more reliable and predictable alternative to conventional and other known or proposed microkeratomes, that at least in part alleviates the disadvantages of the prior art.

It is a further object of the present invention, at least in one or more preferred embodiments, to provide a method and apparatus for use in creating a flap in LASIK operations that will provide relatively safe, smooth, non-traumatic tissue separation while maintaining stable hydration levels.

Summary of the Invention

In a first aspect, the invention provides apparatus for forming a corneal lenticule, including:

a body;

means to apply the body to the anterior surface of a cornea;

means carried by the body for forming a closed or nearly closed incision in the surface of the cornea by cutting in a direction generally parallel to the axis of the cornea, to a predetermined depth, thereby defining a corneal segment bounded laterally by the incision; and

means to cause tissue separation in the interior of the cornea behind the segment to the incision, whereby to separate the segment as a corneal lenticule.

Advantageously, the means to apply the body to the anterior surface of a cornea is arranged to do so substantially without applanation of the cornea.

Advantageously, the means to apply the body to the anterior surface of a cornea is arranged to do so substantially without any increase of intraocular

pressure.

Preferably, the incision forming means is such that the incision is a substantially circular incision. The incision forming means is preferably such that the incision is not quite closed so as to form a hinge about which the lenticule is a hinged flap.

The incision forming means preferably includes blade means, eg. an annular or cylindrical cutting implement with a cutting edge at one end, eg. a trephine blade.

The means to cause tissue separation in the interior of the cornea advantageously includes means to direct a suitable gas under pressure, most preferably air, into said interior, eg. a canula, needle or like device.

Means, eg a vacuum plate, is preferably provided for applying vacuum suction to the surface of the cornea within the incision. Such means may further serve to support the lenticule and maintain its structure during the tissue separation, and to aid complete separation of the tissue within the circular incision (eg by stopping part of the lenticule lifting and releasing the gas).

Advantageously, the apparatus further includes stop means associated with the incision forming means for controlling the predetermined depth of the incision.

Preferably the means to apply the body to the surface of the cornea includes vacuum means, eg. a suction ring. Preferably the suction ring is fixed outside the optical zone of the cornea. Preferably suction created is high enough to facilitate guidance of the cutting implement without movement, but low enough to not permanently deform the cornea.

In its first aspect, the invention further provides a method of forming a corneal lenticule, including forming a closed or nearly closed incision in the anterior surface of a cornea by cutting, in a direction generally parallel to the axis of the cornea, to a predetermined depth, thereby defining a corneal segment

bounded laterally by the incision, and causing tissue separation in the interior of the cornea behind the segment to the incision, whereby to separate the segment as a corneal lenticule.

The incision is advantageously formed substantially without applanation of the cornea, and/or substantially without any increase in intraocular pressure.

The incision is preferably a substantial circular incision. For applications such as LASIK, the incision, preferably substantially a circle, is not quite closed so as to form a hinge about which the lenticule is a hinged flap.

The incision is preferably formed with blade means.

Where circular, the incision may conveniently be formed by an annular or cylindrical cutting implement with a cutting edge at one end, eg. a trephine blade.

Preferably, the tissue separation in the interior of the cornea is effected by directing a suitable gas under pressure, more preferably air, into the interior, eg. by means of a canula, needle or like device, and optionally also by applying vacuum suction to the surface of the cornea within the incision.

Control of the incision to its predetermined depth is preferably effected by stop means associated with a cutting implement by which the incision is formed.

The incision forming means may be driven manually or by a motorised device.

The predetermined depth of the incision is preferably no more than 200 microns, most preferably a maximum is between 60 and 180 microns.

In a second aspect, the invention is directed to apparatus for separating a segment of a cornea for forming a corneal lenticule, including:

a body;

means to apply the body to the anterior or posterior surface of the cornea; and

means carried by the body for introducing pressurised gas, most preferably air, into the interior of the cornea at a preselected location whereby to cause tissue separation in the interior of the cornea by parting collagen bonds, and to thereby separate a segment of the cornea for forming a corneal lenticule.

In the second aspect, the invention further provides a method of separating a segment of a cornea for forming a corneal lenticule, including introducing pressurised gas, most preferably air, into the interior of the cornea at a preselected location, whereby to cause tissue separation in the interior of the cornea by parting collagen bonds, and to thereby separate a segment of the cornea for forming a corneal lenticule.

Preferably, during said parting of the collagen bonds, the surface of the cornea is subjected to vacuum suction.

The means for introducing pressurised gas into the interior of the cornea is preferably a fine canula, needle or like device.

Preferably the suction ring is affixed outside the optical zone of the cornea. Preferably suction created is high enough to guide the cutting implement without movement, but low enough to not permanently deform the cornea.

Preferably said pressurised air is sterile, filtered air, delivered at a low pressure and a low velocity, with the highest likely velocity being approximately 0.1 ml/s.

Preferably the apparatus, in either or both of the respective aspects, is a single-use device.

Brief Description of the Drawings

In order that the invention be more fully understood, a preferred embodiment will be described by way of example, with reference to the accompanying illustrations in which:

Figure 1 is a cross-sectional view of apparatus according to an embodiment of the present invention for forming a corneal lenticule, shown in situ on a cornea while in use for carrying out a method according to the invention; and

Figure 2 is a diagram illustrating one preferred form of the trephine blade of the apparatus of Figure 1, for forming the incision in the cornea.

Description of Preferred Embodiments

The illustrated apparatus includes a body in the form of a suction ring 10, a corneal cutting device in the form of a generally cylindrical trephine blade 20 which is slidable within the cutting ring to form an incision in the cornea, and means in the form of a canula or needle 30 arranged to be inserted into the cornea to a predetermined depth for injecting a pulse of compressed air for causing tissue separation in the interior of the cornea.

Suction ring 10 has an annular underside channel 12 to which vacuum may be applied via an aperture 14 and chamber 15, for applying the suction ring to the anterior surface of a cornea outside the optical zone of the cornea, and thereby stabilising and controlling the cornea. Suction ring 10 and trephine blade 20 are so dimensioned so that the blade is a close but freely sliding fit within the ring. Further suction is applied to the cornea within the blade via a generally circular vacuum plate 16 to stabilise and control the resection and lifting of the flap, ie to support the lenticule and maintain its structure during the tissue separation so the compressed air does not escape before the tissue separation is completed. Plate 16 has a concave undersurface with a network of fine grooves 18 to which suction is applied via aperture 19 and an associated duct network, and a vacuum line 17. Canula 30 extends through a fine bore 31 in plate 16 so as to be longitudinally

adjustable for variation of the depth of injection of the air.

The depth of the circular incision formed by blade 20 is determined by the abutment of locking collar 22, fixed on the exterior surface of the blade, with the outer annular face of suction ring 10. In other embodiments there may be more than one locking collar, and/or the locking collar(s) may be fixed and non-adjustable. Similarly, the depth of canula 30 is determined by the abutment of an adjustably located locking collar 32 on the canula with a further transversely extending plate 35 disposed within trephine blade 20. This plate 35 may optionally serve as an additional vacuum plate spaced outwardly of plate 16 for applying additional vacuum to the space 38 behind plate 16 through a vacuum line 36, to assist the controlled lifting of the flap and optionally attached vacuum plate 16.

In carrying out the preferred method of the present invention, suction ring 10 is mounted on the globe of the eye and suction is applied to the cornea via air aperture 14. Blade 20, is inserted within the inner edge of suction ring 10. The cutting edge 21 at the end of blade 20 inscribes a closed or nearly closed circular incision 52 into the cornea by cutting in a direction generally parallel to the axis 8 of the cornea (and of the blade) to a depth controlled by contact of locking collar 22 with ring 10. To form the incision, blade 20 may simply be driven axially, or it may rotate, or a combination of both. This incision, which is effectively a cylindrical cut, defines a corneal segment 50 bounded laterally of the corneal axis 8 by the incision, The vacuum pressure of the suction ring should be high enough to guide blade 20 through the cornea without lateral movement, but not so high as to permanently deform the cornea. Where the corneal lenticule is to be a flap, eg. in LASIK, blade 20 has a notched area 25 where no or incomplete cutting can take place so that a hinge is formed in the corneal tissue. Vacuum plate 16 supports the corneal segment 50. The depth of incision 52 is preferably appropriate for LASIK, being in the range of 60 to 200 microns.

Canula 30 is now introduced through aperture 31 in vacuum plate 16 and moved so as to penetrate the corneal segment 50 to a chosen depth, usually the same as or slightly less than the depth of incision 52. Locking collar 32 prevents

canula 30 from deeper penetration of the cornea. The canula is attached via conduit (not shown) to a source of sterile, pressurised air. Alternatively a syringe or other appropriate means of introducing air into the needle may be utilised. Instead of air, oxygen or nitrogen may be satisfactory. A corneal lenticule or flap is created by the injection of a low velocity, low pressure, air "bubble" through canula 30. In contrast to the cutting action which would result from a jet, this air bubble acts to separate tissue within the cornea by parting collagen bonds and so gently "pushing" the collagen layers of the stroma apart and separating segment 50 as a corneal lenticule. Suction may also be applied through an aperture 36 which taps into the space between vacuum plates 16 and 35. This is an optional step to provide further suction and ensure that the flap tissue is lifted cleanly from the stromal bed.

In a modified arrangement, canula 30 may wholly or partially penetrate the corneal segment 50 during formation of the incision 52, eg it may travel axially with blade 20.

Where the lenticule is a hinged flap, the flap can then be "flipped" over to expose the stroma to laser ablation, after which the flap can be repositioned, leaving the epithelium and Bowman's membrane intact and the stability of the cornea undisturbed. Alternatively, the method and apparatus of the present invention can be used for removing the epithelium prior to PRK laser ablation, to remove diseased epithelial cells, or to create a corneal button for transplant operations.

Figure 2 shows a suitable form of the cutting implement 20. A cutting blade similar to a commercially available trephine is suitable. The blade should be between 6 and 12 mm in diameter, most preferably around 9.5 mm, so that incision 52 is of similar diameter. As earlier mentioned, the trephine blade is modified with a notched zone 25. This notch creates a hinged area, so that the lenticule is formed as a flap of tissue, can be flipped over and repositioned without displacement from the cornea. This design prevents the occurrence of a full thickness flap, and helps to avoid many of the common accidents that occur with prior art microkeratomes.

The illustrated apparatus is a relatively inexpensive, lightweight (and optionally disposable) innovation that substantially alleviates the disadvantages of the prior art. In particular, it is much safer to use. It is capable of cutting a much thinner flap than is possible with present commercial devices, leaving more tissue depth for laser ablation. The stepped edge of the flap (ie the cylindrical face laterally bounding the flap) provides for better repositioning, with less chance of the flap lifting, than the simple chordal rim of a conventional flap. The use of air instead of water avoids the problem of hydration differences within the cornea and the unpredictable ablation that can result from the use of a water jet, and provides a technique of gently easing apart the collagen layers of the stroma. Other problems associated with prior art mechanical microkeratomes are also avoided, by using a low pressure, low velocity "pushing" action to separate the stroma's collagen fibrils, instead of cutting and tearing. The substantial absence of applanation or flattening of a corneal region avoids a cause of increased intraocular pressure beyond recommended limits.

It will be obvious to a person skilled in the art that modification within the spirit and scope of the aforementioned invention may be readily effected. For example, instead of being introduced after incision 52 is made, canula 30 may already be in position in aperture 31, during operation of blade 20, thereby piercing the cornea as the incision is made. Moreover, the cutting action and the injection of the air pulse may be simultaneous or overlapping, though distinct steps are performed. It is to be understood therefore, that this invention is not limited to the particular embodiments described herein above.

Claims

1. Apparatus for forming a corneal lenticule, including:

a body;

means to apply the body to the anterior surface of a cornea;

means carried by said body for forming a closed or nearly closed incision in said surface of the cornea by cutting in a direction generally parallel to the axis of the cornea, to a predetermined depth, thereby defining a corneal segment bounded laterally by said incision; and

means to cause tissue separation in the interior of the cornea behind said segment to said incision, whereby to separate said segment as a corneal lenticule.

2. Apparatus according to claim 1 wherein said means to apply the body to the anterior surface of a cornea is arranged to do so substantially without applanation of the cornea.

3. Apparatus according to claim 1 wherein said means to apply the body to the anterior surface of a cornea is arranged to do so substantially without any increase of intraocular pressure.

4. Apparatus according to claims 1, 2 or 3 wherein said incision forming means is such that the incision is a substantially circular incision.

5. Apparatus according to any preceding claim wherein said incision forming means is such that the incision is not quite closed so as to form a hinge about which the lenticule is a hinged flap.

6. Apparatus according to any preceding claim wherein said incision forming means includes blade means.

7. Apparatus according to claim 6, wherein said blade means includes an annular or cylindrical cutting implement with a cutting edge at one end.

8. Apparatus according to claim 6 or 7 wherein said implement is a trephine blade.

9. Apparatus according to any preceding claim, wherein said means to cause tissue separation in the interior of the cornea includes means to introduce a suitable gas into said interior.

10. Apparatus according to claim 9 wherein said gas introducing means is arranged to form a bubble of gas that separates tissue by parting collagen bonds and so gently pushes apart the collagen layers of the corneal stroma.

11. Apparatus according to claim 9 or 10 wherein said gas directing means is a canula, needle or like device.

12. Apparatus according to claim 10 or 11 wherein said gas directing means is mounted for movement to penetrate said corneal segment during or after formation of said incision.

13. Apparatus according to any preceding claim, further including means for applying vacuum suction to said surface of the cornea within the incision.

14. Apparatus according to claim 13, wherein said vacuum applying means further serves to support the lenticule and maintain its structure during the tissue separation, and to aid complete separation of the tissue within the circular incision.

15. Apparatus according to any preceding claim further including stop means associated with said incision forming means for controlling said predetermined depth.

16. Apparatus according to any preceding claim, wherein said means to apply the body to the surface of the cornea includes vacuum means.

17. Apparatus according to claim 16 when appended directly or indirectly to claim 6, 7 or 8, wherein said vacuum means is such that suction created is high enough to facilitate guidance of the implement without movement, but low enough to not permanently deform the cornea.

18. Apparatus according to any preceding claim, further including motorised means for driving said incision forming means.

19. Apparatus according to any preceding claim, wherein said incision forming means is such that said predetermined depth is no more than 200 microns.

20. Apparatus according to claim 19 wherein said predetermined depth is in the range 60 to 180 microns.

21. Apparatus according to any preceding claim, wherein said apparatus is a single-use device.

22. Apparatus for separating a segment of a cornea for forming a corneal lenticule, including:

a body;

means to apply the body to the anterior or posterior surface of the cornea; and

means carried by said body for introducing gas into the interior of the cornea at a preselected location whereby to cause tissue separation in the interior of the cornea by parting collagen bonds, and to thereby separate a segment of the cornea for forming a corneal lenticule.

23. Apparatus according to claim 22 wherein said gas introducing means is arranged to form a bubble of gas that separates tissue by parting collagen

bonds and so gently pushes apart the collagen layers of the corneal stroma.

24. Apparatus according to claim 22 or 23, further including means for applying vacuum suction to said surface of the cornea within the incision.

25. Apparatus according to claim 24, wherein said vacuum applying means further serves to support the lenticule and maintain its structure during the tissue separation, and to aid complete separation of the tissue within the circular incision.

26. Apparatus according to any one of claims 22 to 25 wherein said gas introducing means is a canula, needle or like device.

27. Apparatus according to any one of claims 22 to 26, wherein said apparatus is a single-use device.

28. A method of forming a corneal lenticule, including:

forming a closed or nearly closed incision in the anterior surface of a cornea by cutting, in a direction generally parallel to the axis of the cornea, to a predetermined depth, thereby defining a corneal segment bounded laterally by said incision, and

causing tissue separation in the interior of the cornea behind said segment to said incision, whereby to separate said segment as a corneal lenticule.

29. A method according to claim 28, wherein said incision is formed substantially without applanation of the cornea.

30. A method according to claim 28 or 29, wherein said incision is formed substantially without any increase in intraocular pressure.

31. A method according to any one of claims 28 to 30, wherein said incision is a substantially circular incision.

32. A method according to any one of claims 28 to 31, wherein said incision is not quite closed so as to form a hinge about which the lenticule is a hinged flap.

33. A method according to any one of claims 28 to 32, wherein said incision is formed with blade means.

34. A method according to claim 33 wherein said incision is formed by an annular or cylindrical cutting implement with a cutting edge at one end.

35. A method according to any one of claims 28 to 34 wherein said tissue separation in the interior of the cornea is effected by introducing a suitable gas under pressure into said interior.

36. A method according to claim 35 wherein the gas is introduced so as to form a bubble of gas that separates tissue by parting collagen bonds and so gently pushes apart the collagen layers of the corneal stroma.

37. A method according to claim 35 or 36 wherein said gas is directed into said interior by means of a canula, needle or like device.

38. A method according to any one of the claims 28 to 37, further including applying vacuum suction to said surface of the cornea within the incision.

39. A method according to any one of claims 28 to 38, wherein said predetermined depth is no more than 200 microns.

40. A method according to claim 39 wherein said predetermined depth is in the range 60 to 180 microns.

41. A method of separating a segment of a cornea for forming a corneal lenticule, including introducing gas into the interior of the cornea at a preselected location, whereby to cause tissue separation in the interior of the cornea by parting collagen bonds, and to thereby separate a segment

of the cornea for forming a corneal lenticule.

42. A method according to claim 41, wherein said gas is air.

43. A method according to claim 41 or 42 wherein the gas is introduced so as to form a bubble of gas that separates tissue by parting collagen bonds and so gently pushes apart the collagen layers of the corneal stroma.

44. A method according to claim 41, 42 or 43, further including applying vacuum suction to said surface of the cornea within the incision.

45. A method according to claim 44, wherein said application of vacuum suction further serves to support the lenticule and to maintain its structure during the tissue separation, and to aid complete separation of the tissue within the circular incision.

46. A method according to any one of claims 41 to 45 wherein said gas is introduced by means of a canula, needle or like device.

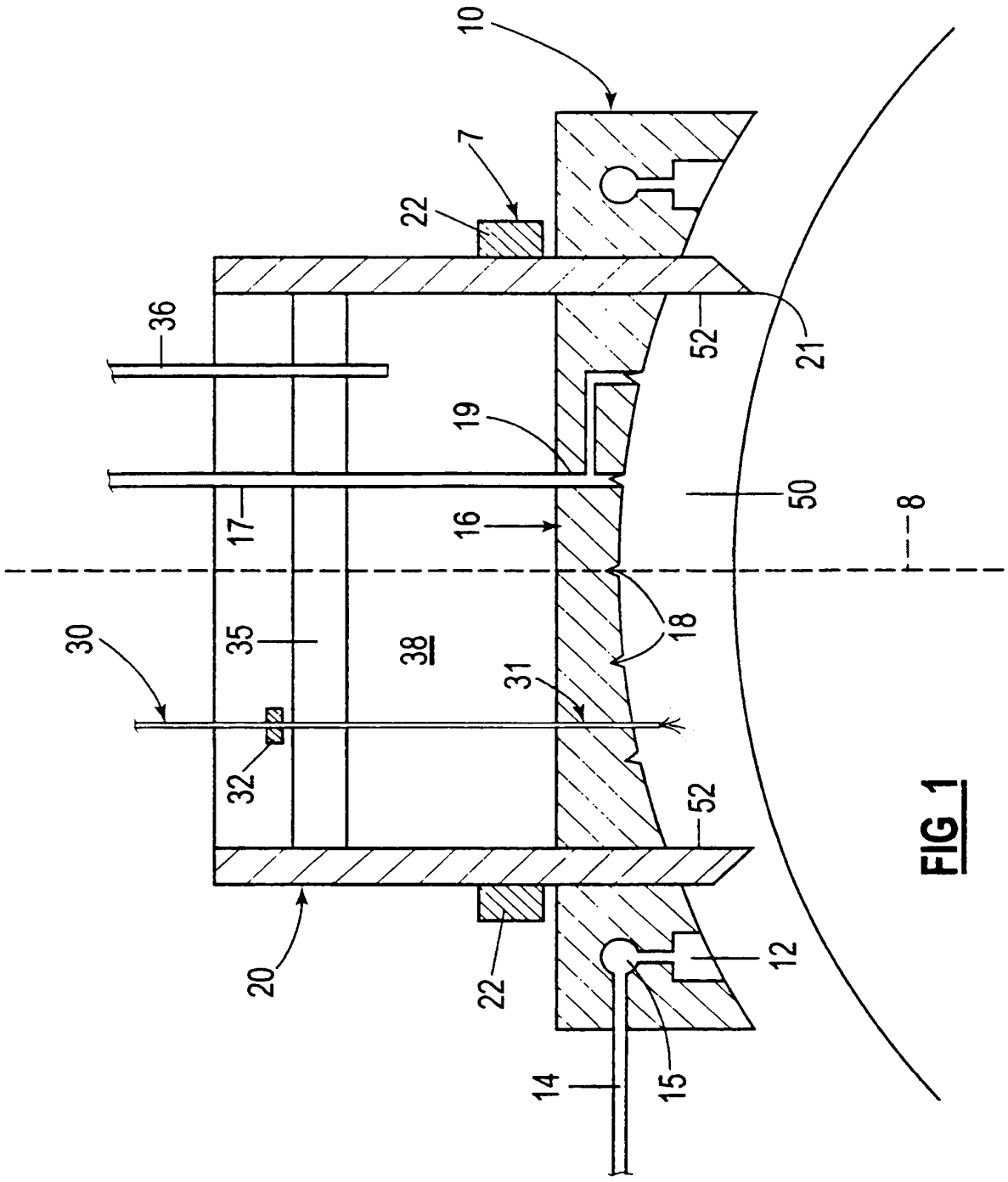


FIG 1

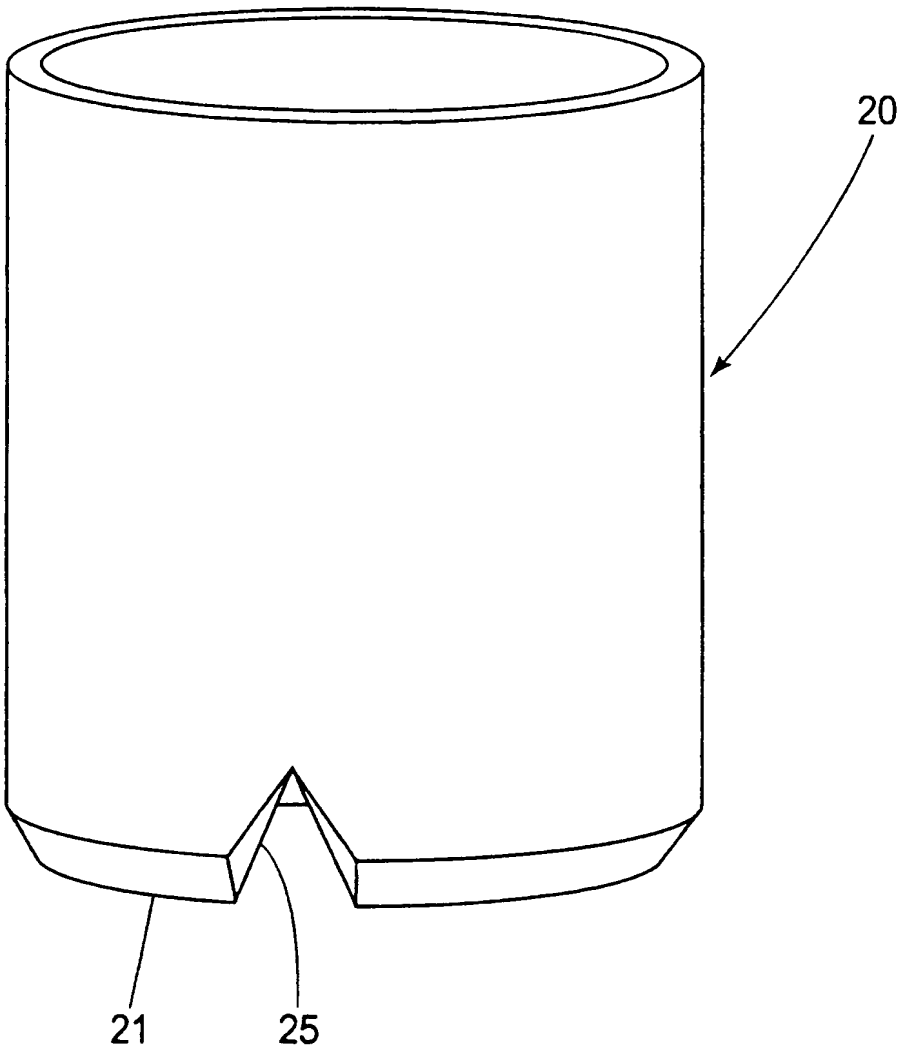


FIG 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00855

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A61F 9/007

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT + keywords

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	WO 93/22988 A (Summit Technology Inc) 25 November 1993	
X	See whole document	1,4-8,15,18-22, 27,28,31-34,39-41
Y		9,11,42
	US 5556406 A (Gordon et al) 17 September 1996	
X	See whole document	1-46
Y	Page 15 lines 20-21	9,11,42
	WO 99/20186 A (Medjet Inc) 29 April 1999	
X	See whole document	1,4-8,15,18-22, 27,28,31-34,39-41
Y		9,11,42

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 September 2000	12 SEP 2000
Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	**A.R. HENDRICKSON** Telephone No : (02) 6283 2415

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00855

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	93/22988	AU	43850/93	US	5312330		
US	5556406	AU	35106/95	CA	2176338	CN	1137230
		EP	734237	NO	961897	PL	314982
		WO	9608212	US	5833701	AU	44198/97
		WO	9810716				
WO	99/20186	AU	11120/99	US	5947987		

END OF ANNEX

PATENT COOPERATION TREATY

PCT

REC'D 31 OCT 2001
WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
T8465040WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00855	19/07/2000	19/07/1999
International Patent Classification (IPC) or national classification and IPC H05B33/22		
Applicant LUXELL TECHNOLOGIES INC.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29/01/2001	26.10.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Besana, S Telephone No. +49 89 2399 8002

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA00/00855

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-22 as originally filed

Claims, No.:

1-23 as originally filed

Drawings, sheets:

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:
see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2,6-8,11,12,14-19,23
	No:	Claims	1,3-5,9,10,13,20-22
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-23

Industrial applicability (IA) Yes: Claims 1-23
No: Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item IV

Lack of unity of invention

1. Reference is made to the following documents:

   D1: US-A-5 049 780 (DOBROWOLSKI JERZY A ET AL) 17 September 1991 (1991-09-17)

   D2: PATENT ABSTRACTS OF JAPAN vol. 1997, no. 12, 25 December 1997 (1997-12-25) & JP 09 204981 A (NIPPON STEEL CHEM CO LTD), 05 August 1997 (1997-08-05)

   These documents were not cited in the international search report. Copies of the documents are appended hereto.

2. The separate groups of invention are:
   i) An electroluminescent device comprising an optical interference member disposed behind the rear electrode (claims 1-3) and a method for producing the electroluminescent device (claims 13-19).
   ii) A kit for retrofitting onto an electroluminescent device, the kit comprising an optical interference member (claims 4-13).
   iii) The use of a silicone gel intermediate a passivating layer and a rear electrode of an electroluminescent device (claim 20).
   iv) An electroluminescent device comprising a passivating layer, which comprises a gel material (claims 21-23).

3. They are not so linked as to form a single general inventive concept (Rule 13.1 PCT) for the following reasons:

3.1 The common feature of groups i) and ii) is the presence of an optical interference member disposed behind a rear electrode of an electroluminescent device for reducing reflectance.
However, this feature is already known from document D1 (see Item V 1.1).

3.2 The common feature of groups iii) and iv) is the presence of a gel material in an electroluminescent device comprising a passivating layer and a rear electrode.
However, this feature is already known from document D2 (see Item V 1.2).

3.3 Furthermore, a single general inventive concept linking together groups i) and iii), groups i) and iv), groups ii) and iii), and groups ii) and iv) was not recognised.
All the claims refer to an electroluminescent device, comprising a layer for passivating the device.
However, the concept of protecting electroluminescent devices with a passivating layer is well known in the art (see e.g. D2).

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The present application does not meet the requirements of Article 33(1) and (2) PCT, because the subject-matter of claims 1, 3-5, 9, 10, 13 and 20-22 is not new.
The interpretation of the subject-matter of claim 4 is given in Item VIII 1.

1.1 Document D1 (cf. col.2 l.4-50; col.6 l.8-56; col.9 l.59-col.10 l.9; Fig.1) discloses an EL device comprising two electrodes (2) and (8), an EL layer (10) disposed therebetween and an optical interference member (16) disposed behind the rear electrode (8) so that reflectance of ambient light is reduced.
Hence, the subject-matter of claims 1, 3-5, 9, 10 and 13 is not novel over the teaching of D1.

1.2 Document D2 (see English abstract) describes an EL device comprising two electrodes (2a) and (2d) and a passivating layer consisting of a silicone gel coating (3) and a water-impermeable layer (4).
Therefore, the subject-matter of claims 20-22 lacks novelty.

3. Dependent claims 2, 6-8, 11, 12, 14-19 and 23 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, in that the additional features are a matter of normal design for the skilled person (claims 2, 7, 8, 11, 14, 23) or in that the features are already known from document D2 (claims 17, 18) or in that the applicant has demonstrated no surprising effect for the claimed feature (claims 6, 12, 15, 16, 19).

Re Item VII

Certain defects in the international application

1. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

2. The units employed on pages 11-13 are not additionally expressed in terms of the units stipulated by Rule 10.1(a) and (b) PCT.

3. According to the requirements of Rule 11.13(l) reference signs not appearing in the description shall not appear in the drawings, and vice versa. This requirement is not met in view of the reference signs cited on p.12 l.15-16 with reference to Fig.3 and reference signs cited on p.20 referring to Fig.13.

Re Item VIII

Certain observations on the international application

1. Claim 4 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined.
   The statements "for retrofitting onto an EL device..." and " when said optical interference member is affixed behind said rear electrode.." do not enable the skilled person to determine further technical features of the claimed kit.
   Therefore, for the purpose of examination the subject-matter of claim 4 is interpreted as defining a kit comprising an optical interference member formed on a substrate.

2. Claims 7-9 and 11 lack clarity (Article 6 PCT) as the claimed features do not further characterise the kit as defined in claim 4.

3. The vague and imprecise statement in the description on p.22 "spirit and scope of the invention" implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
T8465040WO		
International application No.	International filing date *(day.month.year)*	(Earliest) Priority Date *(day.month.year)*
PCT/CA 00/ 00855	19/07/2000	19/07/1999
Applicant		
LUXELL TECHNOLOGIES INC.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The present invention provides a transparent electroluminescent device (30) having an optical interference member (50) which reduces to overall reflectance from the device. The optical interference member (50) is formed on a substrate (70), typically comprising a reflective layer (66), a transparent layer (62), a semi-transparent layer (58) and an anti-reflective coating (54). The optical interference member (50) can then be affixed behind the electroluminescent display (31) with a transparent rear electrode (38). When affixed, the optical interference member (50) can reduce reflectance from ambient light and serve as a passivation layer that protects the elements of the electroluminescent device (31) from exposure to external elements. The optical interference member (50) can increase the reflectance of infra-red ambient light, compared to absorbing films, to thus reduce the overall heating of the display. Furthermore, the optical interference member (50) can absorb light emitted towards the back of the display from the electroluminescent layer (31), thus reducing pixel blooming and improving the overall characteristics of the device. In other embodiment of the invention, the passivation layer can be added without the optical interference layer.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 00/00855

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05B33/22 H05B33/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 615 402 A (MATSUSHITA ELECTRIC IND CO LTD) 14 September 1994 (1994-09-14) claims 1-7	1,3,13
A	EP 0 388 608 A (MATSUSHITA ELECTRIC IND CO LTD) 26 September 1990 (1990-09-26) claims 1-7	1,3,13
A	GB 1 389 737 A (GEN ELECTRIC CO LTD) 9 April 1975 (1975-04-09) the whole document	1,3,13
A	PATENT ABSTRACTS OF JAPAN vol. 015, no. 442 (E-1131), 11 November 1991 (1991-11-11) & JP 03 187186 A (MATSUSHITA ELECTRIC IND CO LTD), 15 August 1991 (1991-08-15) abstract	1,3,13

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2000	26/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl Fax: (+31-70) 340-3016	Drouot-Onillon, M-C

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 00/00855

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 225 (E-0927), 14 May 1990 (1990-05-14) & JP 02 056892 A (NIPPON SHEET GLASS CO LTD), 26 February 1990 (1990-02-26) abstract -----	1,3,13

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
CT/CA 00/00855

Patent document cited in search report	Publication date	Patent family member(s)	Publication d
EP 0615402 A	14-09-1994	JP 2250291 A	08-10-1990
		JP 2553696 B	13-11-1996
		DE 69019051 D	08-06-1995
		DE 69019051 T	11-01-1996
		DE 69032286 D	04-06-1998
		DE 69032286 T	03-12-1998
		EP 0388608 A	26-09-1990
		US 4995043 A	19-02-1991
EP 0388608 A	26-09-1990	JP 2250291 A	08-10-1990
		JP 2553696 B	13-11-1996
		DE 69019051 D	08-06-1995
		DE 69019051 T	11-01-1996
		DE 69032286 D	04-06-1998
		DE 69032286 T	03-12-1998
		EP 0615402 A	14-09-1994
		US 4995043 A	19-02-1991
GB 1389737 A	09-04-1975	NONE	
JP 03187186 A	15-08-1991	JP 2689661 B	10-12-1997
JP 02056892 A	26-02-1990	NONE	

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

NASSIF, Omar A.
Gowling Lafleur Henderson LLP
Suite 4900
Commerce Court West
Toronto, Ontario M5L 1J3
CANADA

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	24.07.2001
Applicant's or agent's file reference: T8465040WO	**REPLY DUE** **within 2 month(s)** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00855	19/07/2000	19/07/1999

International Patent Classification (IPC) or both national classification and IPC

H05B33/22

Applicant

LUXELL TECHNOLOGIES INC.

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☒	Lack of unity of invention
V	☒	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 19/11/2001.

Name and mailing address of the international preliminary examining authority:

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner

Besana, S

Formalities officer (incl. extension of time limits)

Koutsoftas, P

Telephone No. +49 89 2399 7273

I. Basis of the opinion

1. With regard to the **elements** of the international application (Replacement *sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"*):

Description, pages:

1-22 as originally filed

Claims, No.:

1-23 as originally filed

Drawings, sheets:

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims. Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation (Form PCT/IPEA/405) to restrict or pay additional fees, the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with for the following reasons and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees:
see separate sheet

3. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this opinion:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1,3-5,9,10,13,20-22
Inventive step (IS)	Claims	2,6-8,11,12,14-19,23
Industrial applicability (IA)	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item IV

Lack of unity of invention

1. Reference is made to the following documents:

   D1: US-A-5 049 780 (DOBROWOLSKI JERZY A ET AL) 17 September 1991 (1991-09-17)

   D2: PATENT ABSTRACTS OF JAPAN vol. 1997, no. 12, 25 December 1997 (1997-12-25) & JP 09 204981 A (NIPPON STEEL CHEM CO LTD), 05 August 1997 (1997-08-05)

   These documents were not cited in the international search report. Copies of the documents are appended hereto.

2. The separate groups of invention are:
   i) An electroluminescent device comprising an optical interference member disposed behind the rear electrode (claims 1-3) and a method for producing the electroluminescent device (claims 13-19).
   ii) A kit for retrofitting onto an electroluminescent device, the kit comprising an optical interference member (claims 4-13).
   iii) The use of a silicone gel intermediate a passivating layer and a rear electrode of an electroluminescent device (claim 20).
   iv) An electroluminescent device comprising a passivating layer, which comprises a gel material (claims 21-23).

3. They are not so linked as to form a single general inventive concept (Rule 13.1 PCT) for the following reasons:

3.1 The common feature of groups i) and ii) is the presence of an optical interference member disposed behind a rear electrode of an electroluminescent device for reducing reflectance.
However, this feature is already known from document D1 (see Item V 1.1).

3.2 The common feature of groups iii) and iv) is the presence of a gel material in an electroluminescent device comprising a passivating layer and a rear electrode.
However, this feature is already known from document D2 (see Item V 1.2).

3.3 Furthermore, a single general inventive concept linking together groups i) and iii), groups i) and iv), groups ii) and iii), and groups ii) and iv) was not recognised.
All the claims refer to an electroluminescent device, comprising a layer for passivating the device.
However, the concept of protecting electroluminescent devices with a passivating layer is well known in the art (see e.g. D2).

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The present application does not meet the requirements of Article 33(1) and (2) PCT, because the subject-matter of claims 1, 3-5, 9, 10, 13 and 20-22 is not new.
The interpretation of the subject-matter of claim 4 is given in Item VIII 1.

1.1 Document D1 (cf. col.2 l.4-50; col.6 l.8-56; col.9 l.59-col.10 l.9; Fig.1) discloses an EL device comprising two electrodes (2) and (8), an EL layer (10) disposed therebetween and an optical interference member (16) disposed behind the rear electrode (8) so that reflectance of ambient light is reduced.
Hence, the subject-matter of claims 1, 3-5, 9, 10 and 13 is not novel over the teaching of D1.

1.2 Document D2 (see English abstract) describes an EL device comprising two electrodes (2a) and (2d) and a passivating layer consisting of a silicone gel coating (3) and a water-impermeable layer (4).
Therefore, the subject-matter of claims 20-22 lacks novelty.

3. Dependent claims 2, 6-8, 11, 12, 14-19 and 23 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, in that the additional features are a matter of normal design for the skilled person (claims 2, 7, 8, 11, 14, 23) or in that the features are already known from document D2 (claims 17, 18) or in that the applicant has demonstrated no surprising effect for the claimed feature (claims 6, 12, 15, 16, 19).

Re Item VII

Certain defects in the international application

1. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

2. The units employed on pages 11-13 are not additionally expressed in terms of the units stipulated by Rule 10.1(a) and (b) PCT.

3. According to the requirements of Rule 11.13(l) reference signs not appearing in the description shall not appear in the drawings, and vice versa. This requirement is not met in view of the reference signs cited on p.12 l.15-16 with reference to Fig.3 and reference signs cited on p.20 referring to Fig.13.

Re Item VIII

Certain observations on the international application

1. Claim 4 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined.
   The statements "for retrofitting onto an EL device..." and " when said optical interference member is affixed behind said rear electrode.." do not enable the skilled person to determine further technical features of the claimed kit.
   Therefore, for the purpose of examination the subject-matter of claim 4 is interpreted as defining a kit comprising an optical interference member formed on a substrate.

2. Claims 7-9 and 11 lack clarity (Article 6 PCT) as the claimed features do not further characterise the kit as defined in claim 4.

3. The vague and imprecise statement in the description on p.22 "spirit and scope of the invention" implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

MARKS & CLERK
350 Burnhamthorpe Road West
Suite 402
Mississauga, Ontario L5B 3J1
CANADA

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	26.10.2001
Applicant's or agent's file reference: T8465040WO	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00855	19/07/2000	19/07/1999

Applicant: LUXELL TECHNOLOGIES INC.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA:	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Ferro Vasconcelos, M Tel +49 89 2399-[illegible]

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
T8465040WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00855	19/07/2000	19/07/1999
International Patent Classification (IPC) or national classification and IPC		
H05B33/22		
Applicant		
LUXELL TECHNOLOGIES INC.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29/01/2001	26.10.2001
Name and mailing address of the international preliminary examining authority:	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Besana, S Telephone No. +49 89 2399 8000

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA00/00855

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-22 as originally filed

Claims, No.:

1-23 as originally filed

Drawings, sheets:

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:
see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☒ all parts.

☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2,6-8,11,12,14-19,23
	No:	Claims	1,3-5,9,10,13,20-22
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-23

Industrial applicability (IA)	Yes:	Claims	1-23
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item IV

Lack of unity of invention

1. Reference is made to the following documents:

   D1: US-A-5 049 780 (DOBROWOLSKI JERZY A ET AL) 17 September 1991 (1991-09-17)

   D2: PATENT ABSTRACTS OF JAPAN vol. 1997, no. 12, 25 December 1997 (1997-12-25) & JP 09 204981 A (NIPPON STEEL CHEM CO LTD), 05 August 1997 (1997-08-05)

   These documents were not cited in the international search report. Copies of the documents are appended hereto.

2. The separate groups of invention are:
   i) An electroluminescent device comprising an optical interference member disposed behind the rear electrode (claims 1-3) and a method for producing the electroluminescent device (claims 13-19).
   ii) A kit for retrofitting onto an electroluminescent device, the kit comprising an optical interference member (claims 4-13).
   iii) The use of a silicone gel intermediate a passivating layer and a rear electrode of an electroluminescent device (claim 20).
   iv) An electroluminescent device comprising a passivating layer, which comprises a gel material (claims 21-23).

3. They are not so linked as to form a single general inventive concept (Rule 13.1 PCT) for the following reasons:

3.1 The common feature of groups i) and ii) is the presence of an optical interference member disposed behind a rear electrode of an electroluminescent device for reducing reflectance.
However, this feature is already known from document D1 (see Item V 1.1).

3.2 The common feature of groups iii) and iv) is the presence of a gel material in an electroluminescent device comprising a passivating layer and a rear electrode.
However, this feature is already known from document D2 (see Item V 1.2).

3.3 Furthermore, a single general inventive concept linking together groups i) and iii), groups i) and iv), groups ii) and iii), and groups ii) and iv) was not recognised.
All the claims refer to an electroluminescent device, comprising a layer for passivating the device.
However, the concept of protecting electroluminescent devices with a passivating layer is well known in the art (see e.g. D2).

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The present application does not meet the requirements of Article 33(1) and (2) PCT, because the subject-matter of claims 1, 3-5, 9, 10, 13 and 20-22 is not new.
The interpretation of the subject-matter of claim 4 is given in Item VIII 1.

1.1 Document D1 (cf. col.2 l.4-50; col.6 l.8-56; col.9 l.59-col.10 l.9; Fig.1) discloses an EL device comprising two electrodes (2) and (8), an EL layer (10) disposed therebetween and an optical interference member (16) disposed behind the rear electrode (8) so that reflectance of ambient light is reduced.
Hence, the subject-matter of claims 1, 3-5, 9, 10 and 13 is not novel over the teaching of D1.

1.2 Document D2 (see English abstract) describes an EL device comprising two electrodes (2a) and (2d) and a passivating layer consisting of a silicone gel coating (3) and a water-impermeable layer (4).
Therefore, the subject-matter of claims 20-22 lacks novelty.

3. Dependent claims 2, 6-8, 11, 12, 14-19 and 23 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, in that the additional features are a matter of normal design for the skilled person (claims 2, 7, 8, 11, 14, 23) or in that the features are already known from document D2 (claims 17, 18) or in that the applicant has demonstrated no surprising effect for the claimed feature (claims 6, 12, 15, 16, 19).

Re Item VII

Certain defects in the international application

1. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

2. The units employed on pages 11-13 are not additionally expressed in terms of the units stipulated by Rule 10.1(a) and (b) PCT.

3. According to the requirements of Rule 11.13(l) reference signs not appearing in the description shall not appear in the drawings, and vice versa. This requirement is not met in view of the reference signs cited on p.12 l.15-16 with reference to Fig.3 and reference signs cited on p.20 referring to Fig.13.

Re Item VIII

Certain observations on the international application

1. Claim 4 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined.
   The statements "for retrofitting onto an EL device..." and " when said optical interference member is affixed behind said rear electrode.." do not enable the skilled person to determine further technical features of the claimed kit.
   Therefore, for the purpose of examination the subject-matter of claim 4 is interpreted as defining a kit comprising an optical interference member formed on a substrate.

2. Claims 7-9 and 11 lack clarity (Article 6 PCT) as the claimed features do not further characterise the kit as defined in claim 4.

3. The vague and imprecise statement in the description on p.22 "spirit and scope of the invention" implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).